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BELL TELEPHONE FIGURES.

The array of figures presented in the annual report of the Bell telephone system, and set forth on another page, are interesting evidence of the growth of a great electrical industry. The fact that for the first time in some twenty years the Bell report is read in New York instead of Boston is in itself an event that would give unusual importance to the annual meeting of the American Telephone & Telegraph Company, and can only be regarded as indicative of a determination to expand and to be freed from the shackles that have been imposed in Massachusetts upon the financial management of the company. Such a system must grow, and it will go where the conditions most favor that growth, presumably finding them in the financial center of the country. Some of us who witnessed the migration of the old Bell Telephone Company from its modest quarters in Reade Street two decades ago cannot but be glad to welcome back the present organization which has witnessed the creation of the great telephone industry in the interval, and which looks forward to a growth unequaled by any record of the past.

The growth of telephone revenue is in extraordinary contrast to the inertia of telegraph revenue, to be observed on contrasting the figures of this report with those of the Western Union system, for example. It would appear that in the three main items of dividends from sub-companies, rental of instruments and telephone traffic, the system took in about $9,300,000 or $1,873,000 more than in 1899, and this in spite of keen independent opposition and a smaller output of new instruments. There is obviously great strength and vitality in such a system, and so far from being injured by the active competition to which it is now subjected, the claim might well be made that it had braced up and been benefited. Some of the growth shown was doubtless due to the abnormal boom in the now waterlogged Erie system which seems likely to skip dividends, but there was genuine growth and prosperity in the Bell network throughout large sections of the country.

It is nevertheless curious to note these figures and then recall the fact that so rapid has been the growth of the telephone opposition the latter now serves more telephone subscribers than does this parent system. Mr. Cochrane's report shows about 800,000 Bell subscribers. The independents claim 1,500,000, and after liberal pruning and discounting, the number does seem to be somewhere over 1,000,000 to 1,200,000, which, if added to the 800,000 would give this country more than three times as many telephone subscribers as all Europe. It is also interesting to bear in mind that in Europe as here, the spectacle is being presented of competing exchanges in operation in different centers, although the old theory has been that only one exchange can exist in any given community. One thing is certain, and it bodes no ill to the art, namely, that the telephone habit is being cultivated at a rate never before approached, and that when learned it means more business and a larger revenue to all concerned.

LONG DISTANCE TELEPHONY.

The interesting article of Dr. Roeber, of which the third and concluding part is published in this issue, is a notable contribution to a timely subject, and of particular interest from the fact that it discusses on the same basis all three of the methods which have been proposed to enable the length of telephone lines to be in-

creased without increasing the size of the line wire, or to enable the wire to be made smaller for the same length of a line—in general to enable smaller line wires to be used without affecting the telephonic transmission, thereby saving largely in line copper. Heaviside has shown that an increase of the inductance in such lines has the same effect as a decrease in the resistance, and that the ideal condition is attained if distributed inductance be inserted in the line. This ideal condition would be, however, expensive even if practicable, and therefore methods of non-uniform distribution sufficiently approximate for practical purposes have been proposed in the three systems discussed in the article. These three methods differ in the way the distribution is effected and also somewhat in the results likely to be obtained from their application. In the Pupin method, which has attracted so much attention recently, inductances are inserted in series; in the Thompson method, which was presented before the Chicago International Electrical Congress in 1893, they are placed in parallel; and in the Reed method, which was patented a number of years ago, an equivalent of a combination of induction coils in series and in parallel is proposed.

Dr. Roeber in his article applies to the Thompson and to the Reed systems a mathematical analysis analogous to that used by Dr. Pupin for his system. He thus discusses all three systems in a similar way, and arrives thereby at some interesting comparative results. It is shown that by the Pupin system, while the inductance is increased, the resistance is thereby necessarily increased also; by the Thompson system it is shown that the resistance is decreased, but the effective inductance is decreased also; while by the Reed system it is shown that the inductance is not only increased, but the resistance is at the same time decreased. It should be added, however, that the invention of Dr. Pupin involves, besides the use of inductances in series relation, a method of distributing the same in a perfectly definite relation to the capacity and the length of the line.

THE DISTRIBUTION AND CONVERSION OF RECEIVED CURRENTS.

A number of interesting practical observations and deductions appear in the paper read by Mr. Stott last week before the American Institute of Electrical Engineers. The Niagara power plant has passed through the stage in which the generators were the immediate object of concern. The transmission lines have also become well accustomed to their work at 11 kilovolts, although they may still show interesting features of behavior under 22 kilovolts transmission. The interest of this paper centers in the distribution of the power between a number of sub-stations in Buffalo and the means whereby break-downs in one sub-station or section of the city distributing system may be prevented from stopping the transmission to the other sub-stations or sections of the system. An interesting fact is that with 18 inches between the high-tension transmission wires at 11 kilovolts virtually, or 15.5 kilovolts maximum potential difference, an arc once established would travel backwards over the wires to the power house. For such pressures a distance between the wires of 3 ft. seems both practical and desirable.

Another interesting feature is the use of relays in the line very similar to telegraphic relays, and operated by small current transformers with a time interval or delayed contact through the mains of which a circuit breaker is operated after a definite interval of overload. Not only is the relay used for this purpose, but some of the relays are polarized and consist of little motors of the direct-current type, the fields being excited by small potential transformers, and the armatures from small current transformers, whereby either one of the two duplicate supply cables may be automatically cut off in the case of a fault developing underground. It is interesting to observe that as the result of two years' experience one-quarter-inch rubber insulation has been found insufficient for a pressure between adjacent wires of 11 kilovolts, but 9-32 inch is sufficient. Assuming that this is a correct generalization, the value of an extra 1-32-inch of an inch of rubber is significant. Another very interesting observation is that whereas converters have been found more economical and satisfactory than motor-generator sets for transforming from high-tension alternating to railway direct-current service, the reverse has been the case for the supply of Edison three-wire lighting systems. In the latter case the close rgulation required seems to have demanded a greater flexibility and facility of pressure control afforded by the motor generator.

Some curious freaks in the behavior of frequency changers are described in connection with the operation of 60-cycle arc lamps from 25-cycle, high-tension supply. These frequency-changers are synchronous motor generators, the motors having fewer poles than the generators. Consequently, when such sets are operated in parallel, the motors may be running in synchronism and yet the generators may be very seriously dephased by a constant large angle, and it becomes necessary to shake the motors from one synchronous linkage to another until the generators are exactly right. In order to do this, it is said to be necessary to make the motors hunt, or seesaw, such as is possible at the start, until the suitable equilibrium has been obtained. As a rule, hunting between synchronous motors in parallel is an unmitigated inconvenience, and is avoided by all possible means. Here hunting is fostered in the initial stage of throwing a new set into parallelism. The method of starting synchronous motors described in the paper is of considerable interest and importance. A difficulty frequently encountered in the starting of such motors lies in the powerful e. m. f. induced in the field windings by the armature under the influence of the considerable difference between the actual and synchronous speed of the same. This induced e. m. f. in the fields is utilized as a test to determine whether synchronism has been reached before the field is excited. At speeds below synchronism the field circuit will produce visible sparking through a non-inductive resistance, and at synchronism this sparking vanishes.

ROTATION FROM ELECTRIC SPARKS.

An interesting series of experiments by Mr. Dell is printed in another column. It seems that when a disk of shellaced mica is freely supported upon a vertical axis and close above an induction coil spark-gap, so that the sparks pass underneath one edge of the disk, the disk tends to be set in rotation. It is not at all clear that Mr. Dell has fully accounted for the rotation he observed. The phenomenon seems to be very complex; in fact, it is only necessary to read the account of the very variable results observed to appreciate the complexity which exists in the forces at work. Such forces may be thermal, as from the heat of the sparks, or electrostatic in advance of each discharge as from a greater proximity of the disk to one or other terminal of the gap. Again, there may be a convection effected from the negative electrode, whereby elctrified air is caused to pour from the terminal and impinge against the edge of the disk. Again, there may be some cathode-ray action, whereby negatively electrified particles are discharged from the cathode against the disk as in the Crookes tube. Finally, there might be an electromagnetic disturbance in the neighborhood of sudden discharges accompanied by mechanical forces in the front of each wave of disturbance. In the face of so many possible causes belonging to known phenomena, besides whatever causes

may yet be unknown or unrecognized, it would be rash to attempt to diagnose the rotary action described. It can certainly be said that the phenomena offer an interesting field of experimental research, whereby the various forces may be analytically separated and the active ones determined.

The whole subject of the discharge of electricity through gases is bristling with difficulties and unsolved riddles. An interesting paper on this subject, "Gases Regarded as Dielectrics," has recently been written by M. E. Bouty. It is a most remarkable fact that whereas the ether or space devoid of gas seems to be a perfect insulator, and also that whereas gases at ordinary temperature and pressure of the atmosphere seem to insulate perfectly for pressures below a certain critical value, yet at certain low pressures the conductivity of gas by volume is about the same as that of a good electrolyte, such as sulphuric acid in water; and if referred to mass instead of volume, their conductivity is apparently even better than that of copper. It would seem that in gases the laws of electric conduction in electrolytes or solutions are operative, and that in all gas containing a certain number of ions per cubic centimeter the conduction is of the same nature as in a solution containing ions, allowance being made for the difference of freedom in motion of the ions in the two gases. But as it seems that in electrolytes ions are always present in abundance, or that the salt in solution is largely or even wholly broken up into ions in free gases, there may be only very few ions present, and that preliminary action of some sort is necessary to produce the ions. In other words, ether is a non-conductor because it has no ions, and gases are normally insulators because they contain no ions. If, however, ions are produced in a gas either by ultra-violet light or by X-rays or by the action of an electrostatic field, conduction commences to take place by convection or according to the laws of electrolysis, and when the number of ions present is sufficiently great, disruptive discharge will occur. If this is a correct view of the subject, electrolytic conduction is only the electric convection of gases occurring under the modifying circumstances of liquid aggregation, and the convective discharge in gases only a special form under altered physical conditions of electrolytic conduction. Disruptive discharge is a special phenomenon which may occur either in liquids or in gases, and which is subject to complex laws of its own.

THE STATUS OF AUTOMOBILISM.

We greatly regret that there seems to be a tendency to abandon in part the electric automobile service in one or two places. Notably the public carriages in Chicago and the delivery wagons leased to various firms in Boston are reported as to be abandoned, mainly for lack of profitable patronage. The discontinuance of these vehicles has doubtless been determined by entirely adequate reasons, but it is nevertheless a pity, and its effect upon the progress of the art is assuredly for the time being unfortunate. Of course, inadequate patronage and heavy repairs are discouraging, but both these conditions were encountered in the early days of electric railways, and both have been outlived. Automobiles of every kind are in their infancy, have often been rushd upon the market without adequate tests in the factory and on the road, and one and all are well known to be frequent candidates for the repair shop. Batteries give out with painful frequency, but so also do the minor parts of steam outfits and the explosion mechanism of vapor motors. With equal or anywhere nearly equal likelihood of breakdown and liability to annoying and costly repairs, we must confess our personal predilection for sitting over a storage battery rather than a high-pressure steam boiler, or a tank of gasolene. No motive power other than electricity gives the same simple and complete speed regulation, the same freedom from noise and smell, or anything like the same simplicity of mechanism. In steam and gasolene vehicles trouble may and does occur in a variety of places, and it takes something of a mechanic to locate the fault or to correct it. With the electric automobile the chances of breakdown outside of the battery are small, and the mechanism can be made nearly fool-proof, a great desideratum in apparatus intended for use by the community in general.

We have never been accused of undue optimism regarding the storage battery, and have tried to preserve a thoroughly conservative view of its possibilities, but, frankly, we do not believe that there is any inherent reason why the electric automobile should not be entirely successful, particularly in its chosen field of urban service. We well remember when a man with an improved storage battery was looked upon by a large part of the public as ex-officio a charlatan, but the battery has steadily forced its way into central stations for lighting, into isolated plants and finally into electric railway stations. Over and over it has failed when put to work at electric traction, but each failure has taught its lesson and the problem has steadily grown less discouraging, until the most conservative engineers are willing to admit that the battery has a fighting chance even there. The situation in this respect has grown steadily better rather than worse. So in automobile work there have undoubtedly been frequent troubles and discouragements, but in view of past events we are disposed to regard them as natural and temporary concomitants of the growth of new applications, not to be regarded with sinister distrust but with patient hopefulness. Experience in the manufacture of special batteries will work wonders, and in particular we believe that automatic charging devices for the batteries and also automatic safeguards against their abuse will go far toward keeping the electric automobile in the very front rank. It has already scored some really wonderful performances, and we should be very sorry to see the reduction of unprofitable service here and there charged against it as a failure.

As to the other matter, lack of public appreciation, we are inclined to think this a temporary rather than a permanent difficulty. Public carriage service in this country is notoriously at once the worst and the most expensive in the civilized world, chiefly because street car service is so cheap and so good, and so ubiquitous. American practice in this respect has forced the public to look upon cab service not as an every-day necessity, but as a luxury of dubious utility. This is the secret of the enormous popularity of street cars. They may be crowded and stuffy, but they can at least be boarded rather easily anywhere, run at good speed and demand only the payment of a fixed and moderate fare. If the conductors were abusive and drunken and held up their passengers for half a dozen times regular fare in case of rain or if there were ladies in the party at such times, street cars would soon come to be in evil repute. From the general ill odor into which public carriage service has come, a new line of carriages, even automobiles, has a hard task in winning popularity and the accompanying dollars. When an automobile service is brought out on a large scale, modeled not on our present horse cab methods, but on the public carriage systems of London or Berlin, it will surely win its way to popular appreciation and success. But unless worked on a plan obviously more popular than existing competitors it will of necessity have to bear, however well administered it may be, part of the opprobrium that they have honestly earned. The public must be taught how good and useful such a service can be, and its distrust rooted out by experience, before automobiles can take the place we believe they are destined to fill. As the art in general advances and the general difficulties disappear, there will be more encouragement to take up the good work of public education on an adequate scale, and success will be a necessary consequence.

Bell Telephone Annual Report.

A novel feature of the presentation of the annual report on the Bell Telephone system is that the stockholders' meeting to receive it, of the American Telephone & Telegraph Company, on March 26, was held in New York City, the contract room of the New York Telephone Company, on the ground floor of the building in Dey Street, being used for that purpose. The report was signed by Mr. Alexander Cochrane, acting president, who referred to the loss sustained by the company in the death last October of Mr. Hudson, who had been president since 1889, and an official of the company since 1880.

The report, dated for the year ending Dec. 31, showed that while the number of instruments in the hands of licensees in 1891 was 512,407, the number in 1900 was 1,952,412, a gain over the previous year of 372,311, while the year 1899 had showed a gain of 455,255. The miles of extra territorial and toll pole line on Jan. 1, 1901, were 101,087, a gain of 11,795; and of toll-line wire, 607,599 miles, a gain of 105,767. The average daily number of toll connections was 148,528, and the year total 47,800,000, yielding a revenue of $8,972,030. At the beginning of the year 1901, there were 1348 Bell exchanges and 1427 branch offices, an increase respectively of 109 and 240. The miles of wire on poles were 627,897; on buildings, 16,833; underground, 705,269; submarine, 4,203; giving a total of 1,354,202, or an increase of 337,425 miles over 1899. The exchanges reported 508,262 circuits, 32,837 employees, and 800,880 stations, the last figure indicating a gain of 167,934. The estimated number of daily exchange connections was 5,688,986, giving a total for the year of 1,825,000,000. This gives an average per subscriber of from 1 to 15 9-10 calls per day, or an average throughout the United States of 7 1-10, at a cost per connection of from 1 to 9 cents.

The "long-distance" system, if treated as a separate entity, comprises 12,427 miles of pole line and cable, with 167,410 miles of wire, connecting 359 offices, reaching 697,674 stations, of which 438,222, or 62.81 per cent, have metallic circuits.

It is stated that during the year the new construction of the parent company and its two score sub-companies amounted to $28,862,970, while an additional $2,349,103 was expended on real estate. The entire expenditure on the whole Bell system to the end of the year for construction and real estate is put at $168,474,517; while estimates already made indicate that extensions this year will require further expenditure on a large scale.

Th. growth of the system is thus accounted for: "The general adoption of the measured service system and metallic circuit party lines, with corresponding lower rates, has attracted many thousands of subscribers, both business and residence, who were previously deterred by the higher cost of other classes of service." Reference to the new conditions of competition is made as follows: "It is doubtless true that in certain localities, rates too low to cover current expenses and necessary allowance for renewal have been offered, to meet similar rates offered by competitors. We believe, however, such conditions cannot be lasting; and the growth throughout the country, as a whole, has been of a healthy and substantial nature." The recent decision for the defendants in the Berliner suits is referred to with the briefest possible reference, but the statement is made that an appeal will be taken. The purchase of the Pupin patents is passed over without notice.

Some figures are presented as to telephonic development here and abroad. The latest reports that can be obtained for 1899 and 1900 show the countries next in order to the United States, as respects the development of telephone service, to be the German Empire, 229,391 stations; Great Britain, 171,660; Sweden, 73,500; France, 59,927; Switzerland, 38,864; Austria, 32,255; Russia, 31,376, and Norway, 29,446. The total for all Europe is less than 700,000 stations, while the Bell system has over 800,000, with 40,000 private line stations.

In this connection the report says: The year just passed rounds out the quarter century, within which is compassed the discovery and application of the art of transmitting speech by telephone. A brief review of the development and growth of this new industry, which has become so important a factor in commercial and social life, seems appropriate at this time. Twenty-five years ago the wonderful invention of Professor Bell was made known to the world. Twenty-three years ago the first telephone exchange in the world was established in the United States, and from that beginning has been built up the great system of exchanges and the network of connecting lines over which conversation can be held between points over a thousand miles apart.

Twenty years ago there was 47,880 telephone subscribers in the United States, and 29,714 miles of wire in use for telephonic purposes. At the end of last year, there were 800,880 exchange stations equipped with our instruments, and 1,961,801 miles of wire were employed for exchange and toll line service.

The United States has, from the beginning, held the leading place among nations in respect not only of the extensive development of the business, but in the employment of modern and improved appliances, tending to greater efficiency of service.

Treasurer W. R. Driver presented the subjoined balance sheets, dated March 26, in each case.

LEDGER BALANCES, DEC. 31, 1900.

DEBTORS.		
Construction, Equipment and Supplies	$ 16,152,020 72	
Telephones	4,311,928 75	
Real Estate	1,567,018 85	
Stocks and Bonds	71,719,324 01	
Patent Account	24,101 00	
Machinery and Tools	31,477 94	
Cash and Deposits	1,078,071 70	
Bills and Accounts Receivable	5,240,640 27	
American Bell Telephone Co.	22,110,400 00	
CREDITORS.		
Capital Stock		$ 89,100,500 00
Surplus		1,813,199 74
Bonds		10,006,000 00
Reserves		2,416,363 34
*Bills and Accounts Payable		2,928,709 91
Contingent		15,970,210 25
	$122,234,983 24	$122,234,983 24

*Of this amount, $1,282,277.25 is for the dividends payable Jan. 15, 1901, to stockholders of record Dec. 31, 1900.

COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES.

	1899.	1900.
EARNINGS.		
Dividends	$3,044,908 89	$3,846,821 67
Rental of Instruments	1,714,526 54	2,427,037 52
Telephone Traffic	2,668,359 01	3,027,171 85
Real Estate	42,285 11	31,824 67
Interest	217,301 53	201,643 50
	$7,687,381 08	$9,534,499 21
EXPENSES.		
Expenses of Administration	$591,826 34	$746,259 48
Legal Expenses	103,748 46	85,134 07
Interest and Taxes	1,234,275 83	1,376,199 94
Telephone Traffic	1,487,021 88	1,840,847 86
	$3,416,872 51	$4,048,441 35
Net Revenue	$4,270,508 57	$5,486,057 86
Net Revenue, 1900		$5,486,057 86
Dividends Paid		4,078,601 25
		$1,407,456 61
Carried to Reserves	$937,258 22	
Carried to Surplus	470,198 39	
		$1,407,456 61

N. B. The foregoing statement for 1899 is for the purpose of comparison and is made up of the transactions of The American Bell Telephone Company and the American Telephone and Telegraph Company in the same form as those which appear above for 1900.

The old board of directors was re-elected.

Industrial Scholarship.

The Manufacturers Association of New York has appropriated $2,000 for an industrial scholarship, including the cost of tuition for four years and incidental expenses. Boys desiring to compete for the scholarship may make application in writing to Jas. T. Hoile, secretary of the Manufacturers Association of New York, 198 Montague Street, Brooklyn, N. Y. The applicant must be a resident of the City of New York and at least 17 years of age. He must have received not less than three years' high school instruction or an equivalent education. His application must be accompanied by at least two references for scholarship and two for character. Each applicant must present a physician's certificate of good health. The successful candidate will be permitted to make his choice of the school or college he desires to attend, from a list approved by the association. The scholarship will be awarded only to such candidate as is unable to pay his own way through college. Applications should be filed not later than April 20, 1901.

Power Transmission in Utah.

RESULTS AND LESSONS FROM THE OPERATION OF THE LONG-DISTANCE POWER TRANSMISSION AND DISTRIBUTION SYSTEMS OF THE UTAH LIGHT & POWER COMPANY

By J. R. CRAVATH.

THE various transmission plants and the distribution systems of the Utah Light & Power Company in and near the cities of Salt Lake and Ogden, Utah, are among the oldest and most important of their kind, and much can be learned from the experience of this company which is of value to those about to undertake long-distance transmission and distribution from water powers as well as from more recently installed transmission plants. For the many practical points here given as to the working of this company's system, acknowledgment is due to the kindness of R. F. Hayward, chief engineer of this company and consulting engineer for numerous other plants in Utah. Mr. Hayward's extensive experience, covering six years in this work, and his opportunities for observation, constitute him an authority on this branch of electrical engineering, and the readers of this article will appreciate the professional courtesy which has prompted him to furnish such complete information on a class of subjects about which none too much is generally known.

The system of the Utah Light & Power Company comprises three water-power plants, several high-tension transmission lines, and also light and power distribution apparatus in and near Salt Lake City and Ogden, Utah, together with one sub-station for supplying the Salt Lake City Railroad, and some reserve steam plants. Probably in no other city of its size in the United States has electrically transmitted power reached such a relatively important place in the community as at Salt Lake City. The development not only started early, but has been very rapid. The snow-fed mountain streams of the Wasatch Range, to the east of the Salt Lake Valley, offered opportunities to the hydraulic and electrical engineer which were not neglected. To understand the situation a short historical review will be necessary. Although coal is not excessively high, being from $2 a ton for slack to $4.50 for best lump, the proximity of water-power with high head to such a market as Salt Lake City and its surrounding smelters and other power consuming industries led to the erection several years ago of three different water-power plants by three different companies. The Big Cottonwood Power Company completed a plant in the Big Cottonwood Cañon, 14 miles southeast of Salt Lake City in June, 1896. The Pioneer Electric Power Company started its plant in the Ogden Cañon near Ogden, 37 miles from Salt Lake City in July, 1897. The Utah Power Company in 1897 built a plant in the Big Cottonwood Cañon for transmitting power for the Salt Lake City Railroad. These three plants finally became consolidated with the electric lighting interests of Salt Lake City, and are now operated as parts of one complete and comprehensive system, owned by the Utah Light & Power Company, covering a district extending north and south about 60 miles, including Ogden, Salt Lake City, and a district 13 miles south of the latter place, including some large smelters. The accompanying map (Fig. 1) shows the district covered and the lines and power houses.

A brief review of the equipment and location of the three water-power stations will be necessary to a full understanding of the situation.

POWER HOUSE EQUIPMENT.

The plant at Ogden gets its water from the Ogden Cañon, a narrow gorge about 6 miles long (see map, Fig. 1), through which a stream flows, draining a rather large area of high ground. At the head of the cañon is a level valley 4 by 5 miles, which would make a good storage reservoir. At present, however, there is a dam 300 ft. wide and 20 ft. high across the cañon, making a 5-acre reservoir. From this reservoir the water is drawn through two 5-ft. gates into a massive concrete tower, from which it flows in a pipe 6 ft. in diameter, 6 miles to the power house. Five miles of this pipe is wooden stave, and the last mile is steel, taking the water from the wooden pipe at 100-ft. head and delivering it at 450-ft. head. At the power house the pipe line divides into two 6-ft. diameter receivers, one along each side of the building, with 2-ft. delivery pipes running into the power house for each water wheel. This power house (see Figs. 2 and 3), is designed for 10 generators of 750 kilowatts, each direct connected to a waterwheel. Five of these have been put in. The waterwheels are the Knight impulse pattern,

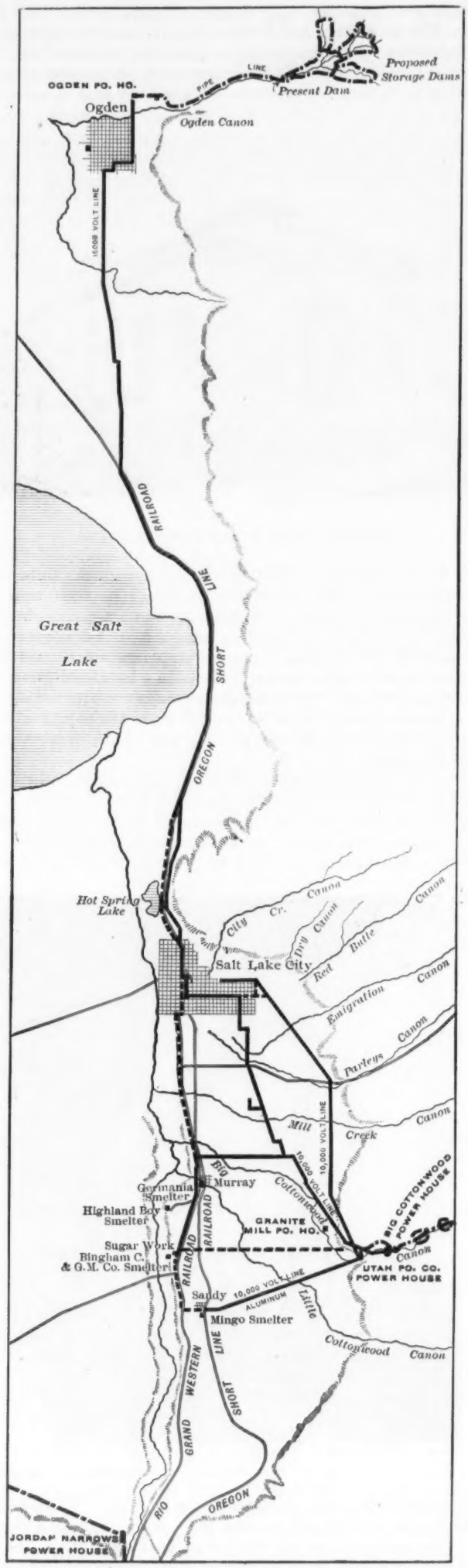


FIG. 1.—SYSTEM OF UTAH LIGHT & POWER COMPANY.

running at 300 r. p. m., and have Knight automatic electric relay governors. The generators are General Electric 60-cycle, three-phase, revolving armature, 750-kw machines, generating at 2300 volts. The exciters are two 500-volt, 100-kw generators direct connected to waterwheels. A Venturi watermeter is placed in each receiver just

FIG. 2.—EXTERIOR OF OGDEN POWER HOUSE.

outside the power house, so that the water consumption can be measured continuously. The distribution in Ogden is direct from this station at 2300 volts. For transmission to Salt Lake City there are nine 250-kw air-blast transformers arranged in delta connection, stepping up to 16,000 volts. The transmission line is 36½ miles long, and consists of two circuits of three No. 1 bare hard-drawn copper wires on the same pole line. The insulators are porcelain. The poles are from 35 to 50 ft. long. For 16 miles the pole line is just outside a railroad right of way, and the rest of the distance passes over open country.

The Big Cottonwood plant, which is southeast of Salt Lake City in the Big Cottonwood Cañon, leads its water from a small reservoir through a 4-ft. steel pipe line, which passes first through a tunnel 500 ft. long, and then down a steep slope to the power house. The pipe line is 1800 ft. long and the head is 380 ft. The receiver at the power house is the same diameter as the pipe line. There are four 600-hp Pelton waterwheels running 300 r. p. m., each with two nozzles. One nozzle is opened and closed by a gate valve, the other has a hood operated from a lever in front of the switchboard for regulation. The regulation is all done by hand. The generators are General Electric, 60-cycle, 500-volt, three-phase, 450-kw. There are two exciters separately driven by waterwheels. On the upper floor of the power house are six 250-kw transformers, air cooled, stepping up from 500 to 10,000 volts. The transmission line to Salt Lake City consists of two three-phase circuits of No. 2 wire (see Fig. 1), 14 miles long, part over rough, mountainous country and part along a country road. Porcelain insulators are used. Part of the distance these circuits are now run on the same poles as the line from the Utah station.

The Utah station is also located in the Big Cottonwood Cañon, and gets its water from a small wooden dam just below the tail race of the other station. For 1¾ miles the water is taken in a wooden flume 4 ft. wide by 3 ft. deep, and is then delivered to a steel pipe 4 ft. diameter, and giving a head of 450 ft. The power house has two 1000-hp Pelton waterwheels running 300 r. p. m., direct connected to 750-kw, two-phase, 60-cycle, 500-volt Westinghouse generators. Exciters are independently driven. The main waterwheels are regulated by a Replogle relay governor, acting on a throttle valve. Step-up phase-changing transformers raise the voltage from 500 volts, two-phase to 11,000 volts, three-phase. The transmission line has two three-phase circuits of No. 3 bare copper wires on porcelain insulators, and is about 12 miles long. This station is operated in parallel with one generator in the Big Cottonwood plant to supply the Salt Lake City Railroad through a sub-station near the middle of the city.

The railway sub-station just mentioned has two two-phase, 300-kw rotary converters supplied from step-down transformers. One of the rotaries is usually sufficient to carry the load. The paralleling is, of course, necessarily done on the three-phase high-tension lines.

The light and power distribution at Salt Lake City is accomplished through the medium of another sub-station near the middle of the city. Here the high tension lines are run in from both the Ogden and Big Cottonwood plants. Both are stepped down to 2300 volts, and the 2300-volt lines are thrown in parallel, thus putting the Ogden and Big Cottonwood plants in parallel through the medium of the 2300-volt secondaries.

DISTRIBUTION.

It has been Mr. Hayward's aim, ever since the consolidation of interests made it possible, to bring everything under one uniform simple scheme of generators and distribution. Fortunately the frequency of all the plants was the same (60 cycles), but there the uniformity ended. As the secondary system is now uniform, so that the plants can be operated in parallel, the difference in transmission voltage is no great inconvenience save as it necessitates greater re-

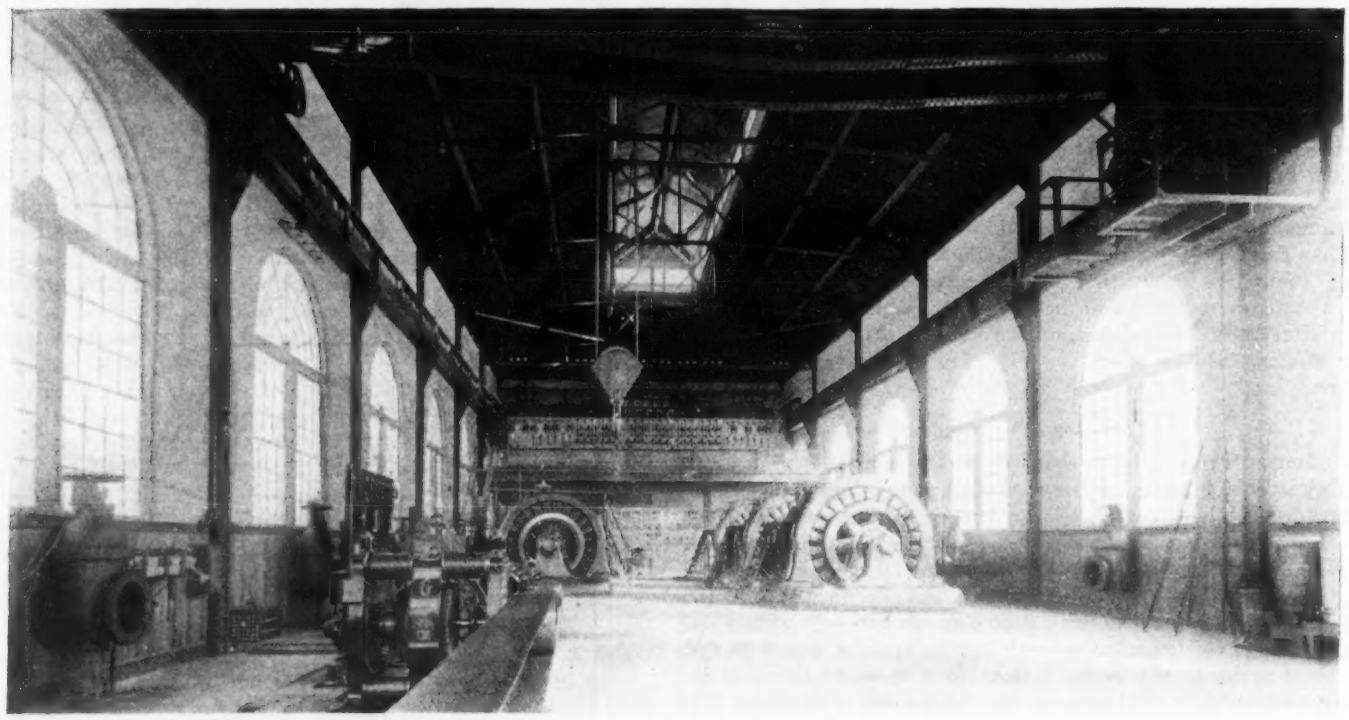
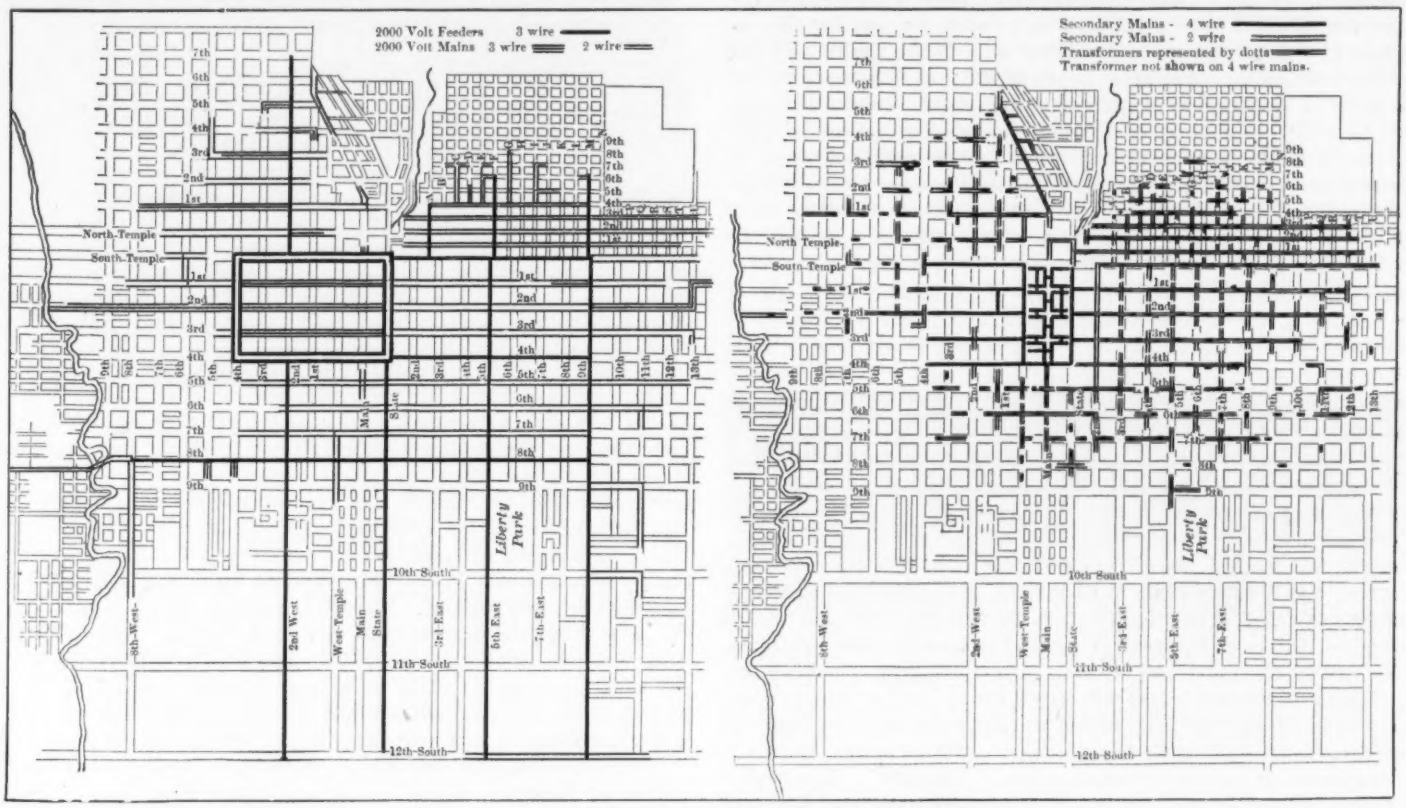


FIG. 3.—INTERIOR OF OGDEN POWER HOUSE.

serve capacity in transformers at the sub-station, and prohibits paralleling high-tension lines. However, it is contemplated to raise the transmission line voltage on both the Ogden and Big Cottonwood lines to about 24,000. This can be done on the Ogden line without rewinding transformers by changing from the delta to the Y method of connection. The Big Cottonwood transformers will have to be rewound. From the light and power sub-station a network of 2300-volt mains is fed. This network is shown in Fig. 4. The primaries of the street transformers are connected delta-fashion, but the secondaries are on Y-connection. When motors under 10 horse-power are to be run they are connected between the outside legs of the Y, which give 200 volts. Motors over 10 horse-power are put on separate transformers. The lights are balanced between the outside legs and the neutral on 115 volts. This makes a very satisfactory scheme of distribution. Six transformers are placed to a block, at opposite corners, and they feed into secondary mains running around the block. Adjacent blocks are tied together through fuses, so that the secondary system in the down-town district is also a complete network. This secondary network is shown in Fig. 5. In the residence district two secondary wires (a leg and a neutral) are first run down a street, balancing one street against another, and as customers increase the third and fourth wires are put in and connection is made with adjacent secondary systems, everything working toward the network idea. Mr. Hayward believes in network and parallel running throughout, as the only ways to secure reliability of service and minimum voltage variations.



FIGS. 4 AND 5.—DISTRIBUTING SYSTEM, SALT LAKE CITY.

At the sub-station there is a small steam plant in reserve which it is expected to increase as the system grows, to reduce as far as possible the chances for interruption of service. There is also an old electric light station near the sub-station which can be run in case of emergency. At present there are in this latter station some synchronous motors driving series arc-light machines. These motors can be run as generators on short notice. It is expected in time to replace all series continuous-current arcs with constant-potential alternating arcs. The series-alternating arc is not liked, because of the complications in the way of high-tension circuits on pole lines which it involves. It is desired to keep the circuits as few and simple and safe as possible. On all pole lines carrying 2000-volt mains, the inner wires between which linemen must climb are at the same potential, and everything possible is done to make it safe for linemen in their dangerous duties. In case constant-potential alternating arcs are run for street lighting, a magnetic switch will probably be used by which all the lights on a section of street can be turned on at once by an inspector. About 500 constant potential alternating commercial arcs are in use in Salt Lake and Ogden.

In order to bring the voltage right on the 2300-volt mains in both Salt Lake City and Ogden and allow for line loss between Ogden and Salt Lake, the step-up transformers on the Ogden line are wound 7 to 1 and 6 to 1 on the step-down. A certain degree of regulation at Salt Lake can be obtained by varying the exciter motors driving arc-light machinery. With heavy load on the line, a variation of 10 per cent can be obtained in this way. Regulation of voltage at Salt Lake City is also obtained by varying the exciting current at the Big Cottonwood generators. As explained elswehere, the waterwheels at the Big Cottonwood plant have no automatic regulators. Those at the Ogden power house have. The hand regulators at the Big Cottonwood power house are, therefore, left untouched, so that they supply constant power, and the variations in demand are taken up by the governors at Ogden. But the exciting current on the Ogden generators is maintained nearly constant, except that such adjustment as necessary is made to regulate the voltage on the Ogden distributing circuits. If the Salt Lake City voltage is to be raised, the Big Cottonwood generators have their fields strengthened. The regulation is controlled by telephone from the Salt Lake sub-station.

It is of value to note the ease with which the different stations having types of alternators are run in parallel. At light loads there is a slight interchange of current between the two stations sometimes, but at heavy loads all these induction and resonance effects are drowned out.

SWITCHBOARD CHANGES.

All of the power houses were originally built with the transformers and transformer switching arrangements on a different floor from the generators and generator switchboard. Under the circumstances, this is an undesirable arrangement. In the Big Cottonwood and Ogden plants, the transformer switches will be moved down onto the main floor where they can be got at quickly by the men attending the waterwheels and generators. Both economy of labor and reliability of service demand this. The high-tension 16,000-volt switchboard at the Ogden plant, as it is at present, is shown in Fig. 6. The low-tension 2300-volt board is shown in Fig. 7.

WATER SUPPLY.

The securing of a reliable supply of water is the cause of much thought and anxiety in connection with an enterprise of this kind. Of course, with several different plants, the liability to interruption decreases, but the experience in Utah as well as elsewhere shows that the constancy of water supply is something about which little was known when the first plants were built. In Utah, where the power houses are located in cañons from 4000 to 5000 ft. above the sea.

where the temperature reaches 40 degs. Fahr. at times, and where the snow falls heavily in places there is a constant menace to water power plants from snowslides and ice dams, this being the more serious because of the small actual volume of water in the streams. In the Big Cottonwood Cañon, for example, two or three snowslides may be expected each year, which will dam the stream partially for 20 hours. On the other hand, in the dry season, the irrigation, which has the right of way over everything demands the entire flow of the stream. For these reasons it is important both for power and irrigation to construct large reservoirs for storage of water. This is more easily said than done in some of these Wasatch cañons, owing to the difficulty of finding bed rock. A large storage dam contemplated for the Ogden plant was never built because of the great depth of bed rock upon which to found it. To provide for irrigation and allow water to be used with economy at Ogden a storage reservoir has been built below the plant so that water need not be wasted by the plant to provide irrigation, as had at first to be done. It is, of course, desirable to have storage reservoirs away from the current of the main stream to prevent them filling up with boulders in flood seasons, but so far the construction of such reservoirs has not been possible for these plants.

The load has had a remarkable growth. That at Ogden, for example, has doubled in two years. Plans are under way for the enlargement of the water storage capacity in both the Ogden and Big Cottonwood Cañons. The great depth of bed rock has made worthless many of the original plans for storing water. Unless a dam is sunk to bed rock there is an immense amount of leakage. In the Ogden Cañon the plan is to build four low inexpensive dams, as shown by the accompanying map, farther up the river than the originally proposed dam. These will give within 25 per cent of as much water as the one big dam originally contemplated, and cost far less. The locations of these proposed dams are shown in Fig. 5.

At Ogden, where the velocity of the water around the intake is slow, owing to the volume of standing water at that point, there is little trouble with ice around the screens, but in the Cottonwood Cañon, where there is a temporary intake and high velocity of water, there is trouble with ice forming on the screens. The reservoir originally constructed for the Big Cottonwood plant could not be used, because of its porosity, but a concrete dam is contemplated, which will give a good intake.

In regard to methods of conveying water the open flume has proven rather unsatisfactory for use around these steep cañons, where falling rocks or snowslides are liable to carry away the whole structure that happens to lie in their path, and cut off the supply of water completely. The "Utah" plant of this company is supplied through a flume, which several times has been broken by falling rocks so that the plant had to shut down until repairs were made. Mr. Hayward believes in general that if the development of a water power is so expensive in proportion to the power produced that the cheapest construction must be chosen on account of its cheapness, the water power is not worth developing. Reliability is essential to the success of every power-transmission scheme, and any pipe line or flume for conveying water to the plant should be thoroughly protected from snow and landslides, and a tunnel or buried pipe line will often be found more economical than a flume or ditch. Mr. Hayward finds that the examination of smooth, gentle slopes at the foot of cliffs shows that these smooth places are frequently caused by snowslides, and are places to be avoided, and in such cases nothing but a buried pipe line or flume heavily timbered over the top should be used.

One of the largest wooden pipe lines ever built is that at the Ogden plant. It is 6 ft. diameter outside and 5 miles long. It is laid in an earth-and-rock cut on the south side of the Ogden Cañon. Unlike many pipe lines it was not laid to hydraulic grade, but drops below the level of the intake in some places as much as 100 ft. For protection from falling rocks a shed of 8-inch by 8-inch timbers covered with 3-inch planking has been built over the pipe most of its length. The shed has an angle of 20 to 30 degs. to the horizontal. It has saved the pipe many times, but has frequently to be repaired, as a result of this duty. Once by falling rocks (on one of the innocent-looking smooth slopes previously mentioned) two staves on the upper side of the pipe were damaged, but not sufficiently to necessitate shutting down the plant until several hours later, when it was convenient. A patrol is kept constantly on the pipe line. Blow-off valves to take out sediment during flood seasons are put at the low points in the pipe line, and air valves put at the high points. Just before the pipe line becomes covered with snow in winter there is some liability of these valves freezing, but after the snow comes there is no trouble. No ice forms inside the pipe even in the coldest weather.

The use of two receivers at the power house, as at Ogden, instead of one is emphatically recommended after experience with both plans.

The Venturi watermeters in the supply pipes at the Ogden plant have given some very valuable practical results in the operation of the plant. Economy of water is quite an object in this plant, because of the limited supply. Formerly it was the practice to run more generators than were necessary, and run them underloaded much of the time. After records began to be kept of the output in kilowatt-hours as compared with the mechanical horse-power of the water delivered by the wheels, the calculated efficiency obtained from the wheels in every-day running was raised from 38 per cent to 60 per cent. The men in charge of the station are held responsible for the efficiency, and they see to it that machines are not run underloaded. While the figures given may not be absolutely accurate, they are probably relatively accurate, which is all that is necessary under the circumstances. The plant is now carrying 600-kilowatts more load than formerly, and using no more water.

WATERWHEEL REGULATION.

In the matter of waterwheel regulation, which is a bugbear in many water plants, the results attained seem to be fairly good. The variable load is, however, but a small per cent of the total, except the railway load, and the supply pipes are large for the load that is being carried. As said before, there are no automatic regulators at the Big Cottonwood plant, but it is run in multiple with the other stations, which have automatic regulators on the waterwheels and consequently they furnish all the regulation. In the case of the railway load the variation in speed does not exceed 2 per cent on the waterwheels in the Utah plant, which furnish the regulation. Replogle governors are employed at this plant.

SWITCHING.

The switchboards at all the plants and at the sub-station have double sets of bus-bars and double-throw switches all through on both high and low-tension sides of transformers, on generators and on feeders, so that flexibility and reliability is assured as to switching arrangements. Figs. 6 and 7 show the Ogden switchboards. One peculiarity of this company's system, as at present operated, lies in the absence of fuses save on the street transformers and secondary distribution. Many other Western transmission plants have adopted the same practice. There are no fuses at the power house in the high-tension transmission circuits or on the 2300-volt street network, save at transformers. Mr. Hayward considers the blowing of a fuse without cause on a large system of this kind as too likely to cause serious results in the way of a general shut down for a few moments to be worth the risking. Of course, an alternating current system distributing current to rotaries, synchronous motors and large induction motors is not a pleasant thing to shut down, even for five seconds, and with everything in parallel on a network, the blowing of one fuse usually means the blowing of many more. When a short circuit occurs, it will usually burn itself off. If it is caused by an arc across the high-tension transmission lines, which occurs when something is thrown across the lines, the voltage will usually be pulled down enough to quickly break the arc.

The throwing of stations in parallel is accomplished preferably at one of the generating stations, or it may be done at the sub-station in Salt Lake City. Both stations are started on independent bus-bars, the synchronizer is put between the bars, and with the aid of the telephone which connects all stations, the speed of the two plants can soon be brought near enough so that they can be thrown together. Once together, they stay so without the slightest difficulty.

Both air-blast and oil-cooled transformers have proven very satisfactory on the high-tension transmission work. On the 2300-volt network on the street, the oil-insulated transformers have shown themselves so far to be much more reliable than the dry. No oil-insulated 2300-volt transformers have been burned out in two years, save a couple which accidentally carried twice full-load for a time while two or three dry transformers usually go out each lightning storm on the 2300-volt circuits.

RELIABILITY OF HIGH-TENSION LINES.

The service over the 16,000-volt high-tension line, 36½ miles long, between Ogden and Salt Lake City, has been remarkably free

from interruptions, the record from October, 1897, to December, 1900, being as follows: On one occasion a hurricane which tore up things generally through the valley broke down some telephone wires across the high-tension lines, but did not break poles or wires. On three occasions boys threw sticks or weeds across the lines, causing an arc between wires and a momentary short circuit. On one occasion an insulator was shot off. The Big Cottonwood and Utah lines have not been so free from interruption. The fact must be faced that wherever lines run through populated districts as they do in this case, there will be some trouble from the throwing of things across the lines and shooting at insulators. While this can be stopped to a great extent by offering rewards for offenders, and the emphasizing of the seriousness of the offense by the company, still such things will occasionally be done.

Mr. Hayward considers that building a transmission line without duplicate circuits so that repairs cannot be made on one dead line while the other is alive so that all will be dependent on the continuity of one line, is a practice that cannot be too strongly con-

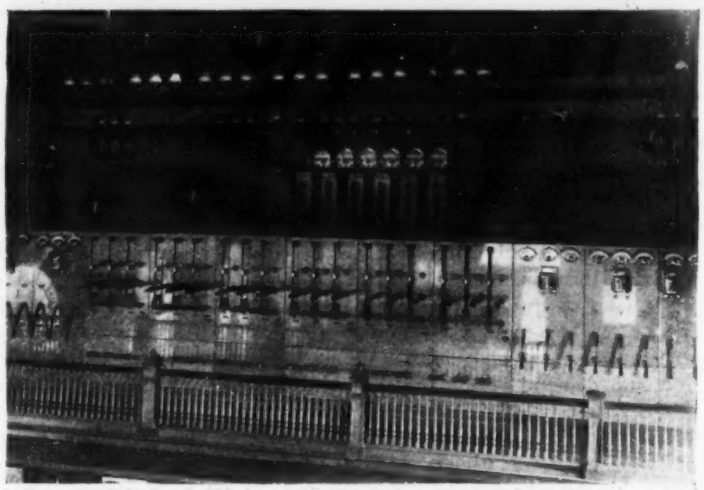


FIG. 6.—HIGH-TENSION SWITCHBOARD, OGDEN.

demned. He believes that if a transmission line for supplying a large community will pay at all it will pay to put it in duplicate. Although repairs have been made on the Ogden 16,000-volt line while live, he does not consider it good practice.

In building a long-distance line of this kind over mountainous country, it is considered that No. 5, or better, No. 4, is the smallest wire that should be put up, for reasons of mechanical strength, and the transmission voltage need not be higher than will transmit the power over this size line with 10 per cent drop, as it is thought that a scheme that will not stand this loss is not worth working out. When these things are considered the necessity for exceedingly high voltages in many plants is not apparent. This company has some solid aluminum wire on a 6-mile line from the Utah plant to some smelters south of Salt Lake City, consisting of three No. 2 aluminum wires. This wire was ordered specially soft and was not stretched very tight, and the results have been perfectly satisfactory. A neighboring transmission line (the Provo) has found it advisable to replace some solid aluminum conductors with stranded aluminum, owing to the brittle hard spots in the solid single conductor.

While it has been the practice with most transmission lines so far constructed to run them as straight as possible across the mountains to save distance, Mr. Hayward is decidedly of the opinion that this is a mistake where accessibility is sacrificed for straightness. A line upon which much is depending must be patroled and accessible for repair, and it is better to go a few extra miles if necessary to secure these things rather than put the pole line where it is a laborious task to get at it in summer, and next to an impossibility in winter.

COST OF POLE LINES.

The cost of a pole line suitable for a transmission of this kind is a matter of considerable interest. The cost of the Ogden transmission line is given as approximately $2,500 per mile. This has six No. 1 wires, on porcelain insulators, and is on poles set 50 to the mile. The poles are mostly 35 ft., except in Salt Lake City, where they are 50 ft. Attention is called to the fact that the pole line, independent of the copper, is such a large proportion of the expense that an increase in voltage to reduce the copper required would not proportionately reduce the total expense, and in many cases would put a practical limit to the desirability of increasing the voltage. For example, it is figured that the copper on the Ogden line did not cost more than $1,000 per mile, and that, therefore, if an increase in voltage could have halved the copper required, the cost of the line would have been reduced only to $2,000 per mile, provided there was no extra expense for insulators, etc., due to the increase in voltage.

POLES.

The poles on this company's lines come from Northern Idaho. They are straight and slightly tapering. None are used less than 8-inch diameter at the top. The 35-ft. pole makes the stiffest cross-country pole line, but it is found that in the Utah bench lands, consisting of sand and gravel, it does not take many years for the pole to rot away just below ground; and if 40-ft. poles are used they can be cut off close to the ground when rotten and the poles set 5 ft. lower. It may prove a good investment to put cement around poles in this soil. Experiments are being made with it. It has been put 14 inches thick for a depth of 2½ ft. around some poles in a specially bad spot at a cost of 80 cents per pole. Fifty poles to the mile is the minimum number that should be set, according to the experience in this country.

INSULATORS.

The insulators on the Big Cottonwood line were among the first high-tension insulators turned out and were made by the dry process. Fully one-third of them have had to be replaced. The insulators on the Ogden line were made by the Imperial Porcelain Works, and tested to 50,000 volts, as were those on the Utah line. Mr. Hayward reports no breakdowns of insulators on either of these lines. On the Cottonwood line it has never been found that a punctured insulator will cause a direct short circuit. If the insulator punctures, a small arc is formed from the porcelain into the pin, and the pin is gradually burned away until finally it breaks off if not attended to. It is the breaking of the pin and crossing of the wires that causes the trouble on the line, and not the original puncture. There is no instance of a pin being charred where the insulator was not punc-

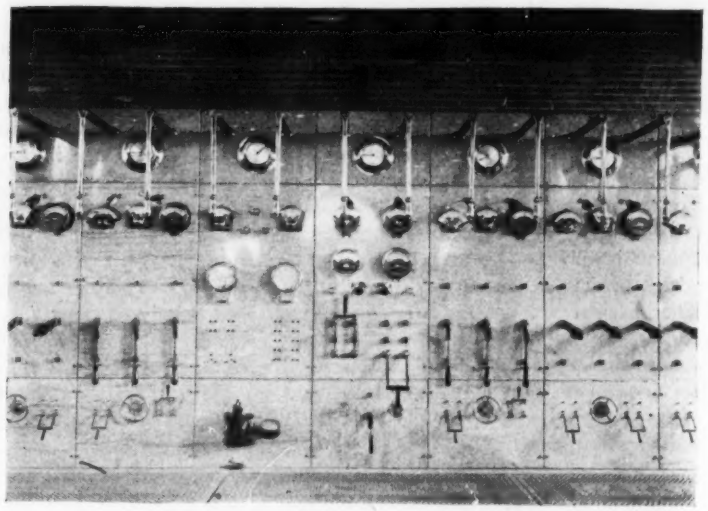


FIG. 7.—2300-VOLT SWITCHBOARD, OGDEN.

tured, which shows that up to 16,000 volts at least there is no burning of pins due to leakage over the surface of insulators, as has sometimes been supposed. As elsewhere, difficulty has been experienced with boys shooting at insulators with rifles, and, in fact, this is the most serious problem at the present time.

In one instance, where a boy threw a stick across the wires, a wire was burned off and fell to the ground. The power was interrupted while the wire was burning off, which lasted a few seconds, but after it fell to the ground things went on as if nothing had happened. Of course, this would not have been possible had any portion of the circuit been grounded permanently.

The wires on the Ogden circuit are transposed every half mile in a 50-ft. span, which is found to be a good plan, as it throws little side strain on the insulators, and it is not necessary to dead end the wires.

MISCELLANEOUS TRANSMISSION-LINE NOTES.

In making repairs on high-tension lines the circuit to be worked on is cut out, grounded and short circuited to prevent all danger

from crosses with live lines while the men are working. The telephone is considered indispensable in the operation of a system of this kind, and indeed it is hard to see how it could be run at times without direct telephonic communication from one plant to another. The telephone wires on these lines are run on a short cross-arm always at least 6 ft. below the transmission lines. On the Ogden line the wires are transposed every five poles, and on the Big Cottonwood every pole. There is no difference in the working of the two lines. Men are sent out just as promptly to fix troubles on telephone circuits as on high-tension lines. On account of static discharges, the call bells only are kept continuously in circuit, and the transmitter and receiver circuit is thrown in for conversation by a double-pole baby knife switch. The sub-station in Salt Lake City is the "central office" for the system. Portable instruments are carried by inspectors so they can climb a pole anywhere along the line to talk to the power houses.

LIGHTNING PRECAUTIONS.

The experience with lightning in Utah is that while thunderstorms are not as frequent as in Colorado mountains they are severe when they do come. This company's experience has found satisfaction in the G. E. Wirt arresters. No static discharge wires are run along the transmission lines. The Wirt arresters are placed at generating and sub-stations. The plain metal cylinders of these arresters are placed with a 1-32-inch spark-gap between cylinders, and one of these gaps is allowed for every 600 volts line potential. In addition to this, there is in series with the arrester a graphite resistance of 80 ohms per 1000 volts on the line. During a thunderstorm small blue sparks frequently give evidence that there is a discharge over the arresters, but the line current does not follow across. Westinghouse-Wurts arresters are used at the Utah plant, and at the railway sub-station, also with good results. In one instance, a stroke of lightning came which splintered poles and jumped around among the power-station apparatus generally, but such things, of course, do not occur often, and probably no lightning arrester on earth could divert such strokes entirely.

LOAD.

The maximum winter evening load is now nearly 5500 horse-power, including all the stations. Besides electric lighting, which is very generally used in the city, there is a good load of motors in all sizes. There is about 2600 horse-power connected for service. There are a few direct-current 500-volt elevator motors driven from the railway station, but most of the motors are three-phase induction motors run off the regular three-phase distribution system. To keep down fluctuations due to starting of these motors, as far as possible the type having internal resistance in the armature is used. The resistance is cut out as the motor speeds up by means of a knob which protrudes out through one end of the hollow armature shaft. The drop-in voltage at starting is much less than with reactance coils. As to motor-circuit rates, a certain fixed rental is charged for power dependent on the indicated power taken by the motor in service, to which is added a certain sum per kilowatt-hour used. In effect, it is really a very low kilowatt-hour charge combined with a high minimum rate.

The Metric System in Great Britain.

A report issued by the Decimal Association, of which Sir Samuel Montague is president and Lord Kelvin, Alexander Siemens, Sir Henry Roscoe, and other representatives of science and industry are members of the executive committee, has issued a report which shows that the metric system is steadily gaining strength in Great Britain. The British Education Department last year required that instructions in the principles of the metric system shall be given in the common schools. At the congress of the Chambers of Commerce of the British Empire held in London June last, a resolution was passed advocating the legalization of the metric system of weights and measures in all parts of the empire (excepting India) for all purposes, and that after a period of two years it be everywhere rendered compulsory. The report states that in Canada the Government is said to be seriously considering the adoption of metric weights and measures. In Russia there is a growing disposition on the part of the Government to adopt the method, and there are reasons for believing that an important step will be taken in that country shortly. Replies to a circular addressed by the British Government to its representatives in Europe showed that in all cases the change to the metric system was made without much difficulty, that there has never been any desire to return to the former system in use, and that the change to the metric system has assisted the trade of the countries which had adopted it. The report states that the representatives of the leading British trades unions continue to be warm supporters of the metric system, and are always ready and willing to give assistance in advocating its adoption. The names are given of 150 members of Parliament who have notified their approval of the compulsory adoption of metric weights and measures, and it is added that there are 20 more members known to be favorable, but authority to publish their names has not yet been received.

Marconi Wireless Telegraph Patents Sustained.

Infringement suits against Mr. G. Marconi, the inventor, begun two years ago by Lyman C. Learned, of Boston, were dismissed on March 19 in the United States Circuit Court by Judge Coxe. Mr. Learned sued as the assignee of Professor A. E. Dolbear, of Tufts College, for damages to the amount of $200,000, and the issue of an injunction restraining Marconi from using apparatus for wireless telegraphy, said apparatus being alleged by the plaintiff to be covered by patents issued to Dolbear.

The original complaint in the case set forth that Dolbear was the original inventor of the system, that his patents were issued in December, 1882, and October, 1886, and assigned to Learned in July, 1899. The complaint further stated that the apparatus for wireless telegraphy exhibited in the diagrams of Marconi's patents was impractical, and that the defendant well knew this. It had, the complainant alleges, only commercial value when one terminal grounded was used for transmission and one for receiving, and hence that contracts entered into by the defendant for commercial purposes were carried out by recourse to the plaintiff's patented instruments or instruments similar. Therefore, application was made for the injunction and demand was made that Marconi be directed to pay over profits to the plaintiff.

The defendant, Marconi, applied similar criticism to the apparatus of Dolbear. It was useless, and not adapted for any commercial purposes, his defense alleged. For the rest, he set up a general denial that his apparatus or any part of it was an infringement of the plaintiff's.

Mr. Marconi's answer was supported by two expert witnesses called on his side, Dr. John Ambrose Fleming, of the University College, London, and Chas. R. Cross, Thayer professor of physics at the Massachusetts Institute of Technology. Dr. Fleming in his testimony, which was made in the form of a deposition, said that he had tried the Dolbear patent instructions and had failed to obtain any such signals or effects as were described therein. He also said: "The patentee (Dolbear) appears to be under the impression that he can raise and maintain the potential of the earth at one place by connecting that spot to the positive pole of an insulated battery. This, however, is absolutely incorrect and opposed to every-day experience. Hence both on theoretical grounds and as the result of my experiments I am of opinion that the arrangements described by Dolbear do not constitute any practical or useful art. I have tried and seen tried all the apparatus which is figured in the specifications of the Marconi patent. I am confident that, given suitable dimensions, signaling could be achieved by it over any distance, and I have not experienced any difficulty in obtaining transmission of signals through space by means of Hertz waves. There is no real similarity between the work of operation of the apparatus described by Marconi in his patent 586,193 and that described in the Dolbear patent 350,299. The apparatus employed by Marconi depends on the production of electric waves. The essential element is the spark gap. This spark gap is entirely absent in Dolbear's arrangement."

Pan-American.

In a communication from Professor G. F. Sever, superintendent of electrical exhibits at the Pan-American Exposition, Buffalo, we are informed that there will be an extensive collective section in the Electricity Building in charge of a curator, Mr. W. J. Marland, of 132 Nassau Street, New York City. The plans are for a flat rate for individual exhibitors, covering the cost of space, attendance, light, platform and installation. A space 20 by 16 ft. has been set aside for this exhibit, and it can be enlarged if the demands become pressing. Already a large number of exhibitors have signified their desire for representation in this space.

Electric Lighting of the Thames Embankment.

A MOVEMENT for the electric lighting of the Thames embankment, which was inaugurated in 1884 (after the Jablochkoff candles, installed in 1878, had been abandoned), reached its conclusion Feb. 23, of the present year, when the plant erected was started with public ceremonies, in which the chairman and members of the London City Council and members of the Councils of the City and Westminster participated. As the plant consists of only four 70-hp units, the importance thus assigned to it is a commentary on the present state of arc-lighting development in London.

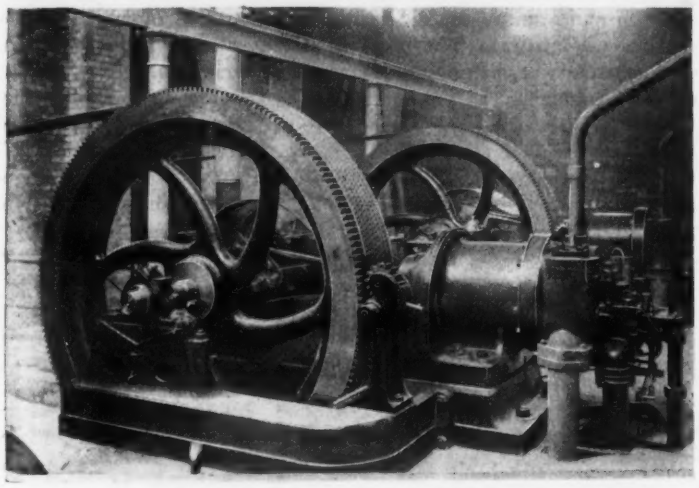


FIG. 1.—ONE OF THE GAS ENGINES.

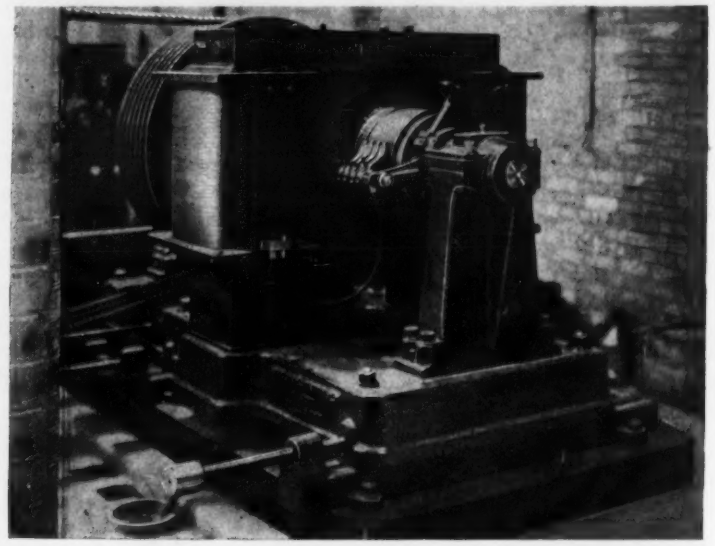


FIG. 2.—ONE OF THE DYNAMOS.

The station is a neat-looking building of Portland stone faced with bricks on the inside. The engine-room is in the basement, the dynamos being situated under the pavement; there are also offices, meter and lamp-testing rooms, and quarters for the resident foreman. The plant consists of four 70 b. h. p. gas engines, driving dynamos by means of six cotton ropes. The engines are of the "Stockport" type, fitted with self-starters and duplicate ignition, and run at 210 r. p. m. with a guaranteed consumption at full load of not less than 17 cubic ft. of gas per b. h. p. per hour. They are governed on the hit-and-miss principle, and the variation of speed is guaranteed to be not more than 1½ per cent above or below the normal. The dynamos are of the Manchester type, having an output of 70 amperes at 500 volts when running at 500 r. p. m. For lighting the building and meter testing a battery of 56 E. P. S. cells is shortly to be fixed, and these will be charged by means of a 20-kw motor generator built by the contractors for the switchboard, which runs the whole length of one end of the engine room. This board is made entirely of teak, each fuse and switch being separately mounted on enameled slate. The instruments are of the Kelvin type, and there are single-pole switches and circuit-breakers for each dynamo. The circuits are controlled by double-pole five-way lever switches with carbon break, enabling any group of circuits to be controlled by any dynamo; each circuit is protected by a double-pole fuse, and there is the usual complement of fixtures for controlling the motor generator and cells. The cables are taken from the switchboard to teak boards near the entrance to a subway 6 ft. high by 4 ft. broad, which passes under the roadway to the river side of the embankment. On these boards are fixed a number of copper links, each link being separately mounted on slate, by means of which the circuits can be disconnected for testing. The cables are composed of seven strands of No. 16 S. W. G., insulated with paper lead-covered, served, armored and again served. There are also several cables for common returns composed of seven strands of No. 14 S. W. G. These cables on the river side of the embankment are laid in the subway which was originally built to lighten the wall. On the land side the cables will be laid direct in the ground.

Several suggestions were considered by the Council with regard to the positions of the lamps, but it was finally decided to light the embankment from the footway kerbs, and utilize the old gas standards on the parapet of the Embankment and Westminster Bridge. At present only the lighting of the parapet lamps along the Embankment has been completed; the standards remain the same. New lanterns have, however, been fixed of almost exactly similar design to the old gas lanterns, except that holophane glass has been used for the bottom half. Opal glass has been used for the top half, and there is an opening through which the top of the lamp projects. The appearance of the post is shown in one of the illustrations. The addition of a cap at the top of the lantern is under consideration. There are 67 of these posts along the parapet, the posts being about 22 yards apart. The lamps take 6 amperes and are run on six circuits

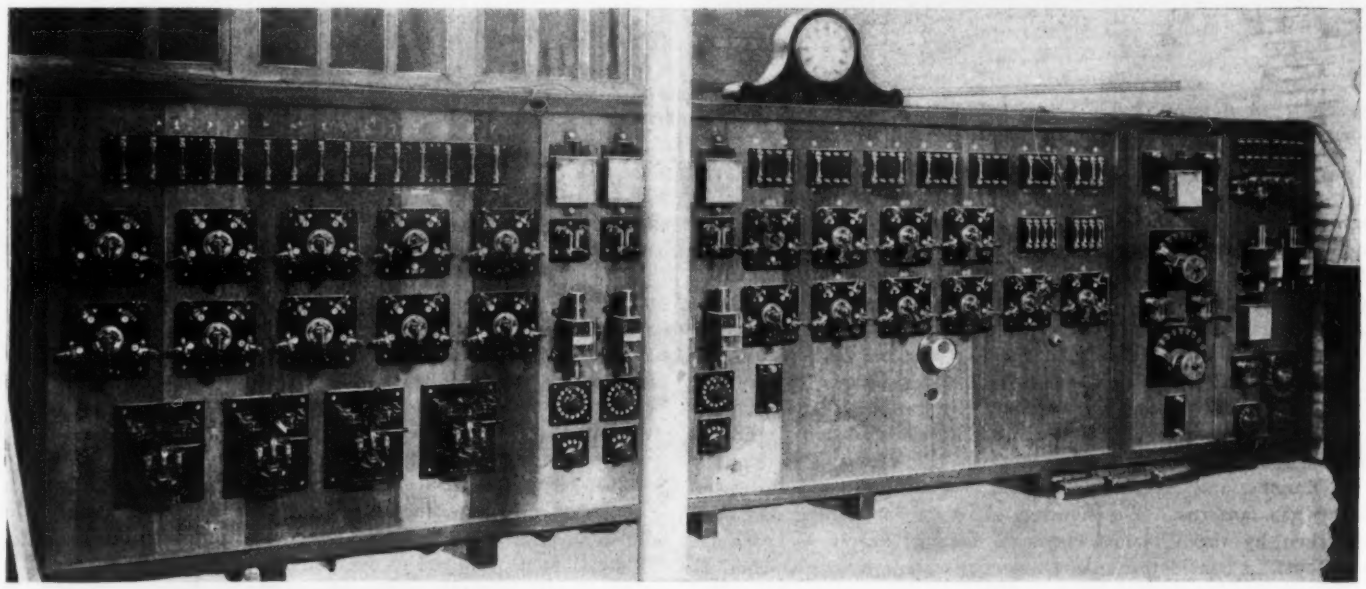


FIG. 3.—SWITCHBOARD, THAMES EMBANKMENT PLANT.

of 10 lamps and one of 7 lamps, and are alternately on separate circuits, so that every alternate lamp can be put out after midnight. The lamps are of the open, double-carbon, clutch type, and burn for 40 hours without retrimming. The chief feature of the lamp is the arrangement of the positive carbons, which slide in brass tubes which pass right up through the mechanism of the lamp, thus enabling the lamp to be very short considering the time it will burn without attention.

The only difficulty encountered was in drawing in the leads from the subway into the standards, owing to the arrangements only being suitable for gas, so considerable care had to be taken. As there is no provision for placing automatic cutouts in the pillar, these are to be placed in the subway, but they have not yet been so fixed. It is hoped that in another three months the rest of the lighting will be completed, when 79 more lamps will be placed along the curbs of the embankment and on Westminster Bridge. The standards for the embankment will be placed alternately on either side of the

FIG. 4.—LAMPS ON THAMES EMBANKMENT.

street, the lamps being separated by a distance of about 90 yards. The posts will stand about 32 feet, the center of the arc being about 25 ft. from the ground; they will be of a handsome design, with four baby dolphins where the base and pedestal join, to harmonize with the parapet standards. They will be fitted with wrought-iron brackets, with some artistic pretensions, differing from the usual cast-iron monstrosities that disfigure London. On Westminister Bridge the existing standards will be utilized, and the lamps will be fitted in the center branch of each of the three branch standards over the piers, the branch being, of course, suitably modified, and at the foot of Northumberland Avenue three arcs will be placed in the three existing gas lanterns. The lighting of Waterloo Bridge has been undertaken by the Charing Cross & Strand Supply Corporation free of cost, in consideration of concessions made by the Council as to the company's mains being allowed to cross over the bridge. The lamps will be of the same type as those on the parapets except that they will take 12 amperes and burn for 60 hours without retrimming, and along the embankment lowering gear will be employed.

The lighting, as far as it is at present carried out, is an unqualified success, the ground illumination being practically uniform, and the appearance of the standards excellent. Our contemporary, the *Electrician*, from which we borrow the above description and illustrations, considers that the Council would have been better advised to have procured powers to take current from one of the existing companies' stations; and even after it had settled to establish its own installation a compacter and more economical arrangement would have been to employ direct-driven steam dynamos.

The Long Distance Telegraph and Telephone Systems of Pupin, Thompson, and Reed—III.

(Concluded.)

By E. F. Roeber, Ph.D.

VII. THE REED SYSTEM.

IN this system the whole line is divided into a number of equal parts connected together by mutual inductance. The current in each must satisfy the differential equation (1), of which (2) is the general integral. The problem is here also to fulfil the boundary equations at each point where two sections of the line are connected together by a transformer. These boundary equations can be written in a way which clearly shows the relation of the Reed system to the Pupin and the Thompson systems, and also the differences between these systems. It will be shown that the arrangement of the transformers shown in Fig. 9 is mathematically equivalent to the arrangement shown in Fig. 10, which is better adapted for formulating the boundary equations in our case. As this mathematical equivalence between the two arrangements in ordinary alternating-current practice is well known (see, for instance, the analytical proof of Mr. C. P. Steinmetz in his Alternating-Current Phenomena and Apparatus, second edition, pp. 182 to 185), I will restrict myself to a graphical explanation of the principle, as far as necessary for our purpose.

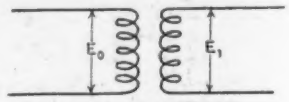


FIG. 6.—TRANSFORMER.

Let us consider any transformer connecting one section of the line with the adjacent section, as in Fig. 6. The number of turns in either primary or secondary winding is n, hence the ratio of transformation unity. Let E be the electromotive force induced in each turn, hence $n\,E$ the electromotive force induced both in the primary and in the secondary winding. The internal resistance, reactance and impedance of the primary and also of the secondary winding may be represented by r, x, z, respectively. Here the reactance refers to the "true self-inductance" only, or to the cross flux interlinked with one coil only, while it does not relate to the mutual inductance. Let the electromotive force at the terminals of the primary and secondary windings equal E_0 and E_1, respectively. The diagram of the transformer is then given in Fig. 7. Φ represents the magnetic flux, $n\,i_\infty$ the total magnetomotive force, to which this flux is due. It is leading before the magnetic flux, on account of hysteresis and eddy-currents. $n\,i_\infty$ is the resultant of $n\,i_0$ and $n\,i_1$ the magnetomotive forces of the primary and secondary circuits. The e. m. f., E_0, impressed upon the terminals of the primary winding is the sum of the e. m. f. $i_0 z$, consumed by the internal impedance, and of the e. m. f. required to overcome the induced e. m. f. $n\,E$. The e. m. f. $n\,E$, induced in the secondary winding, is the sum of the e. m. f., $i_1\,z$, consumed by the internal impedance, and of the e. m. f. E_1 at the terminals of the secondary winding.

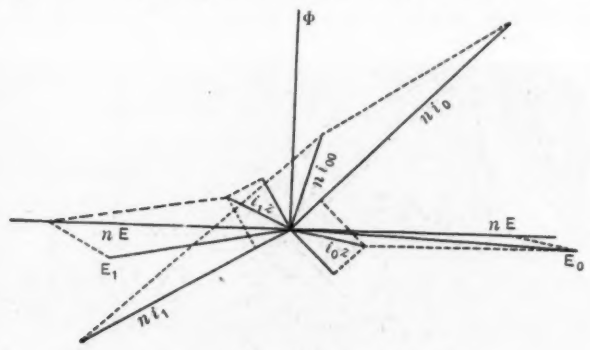


FIG. 7.—TRANSFORMER DIAGRAM.

Now, it is evident that the same Fig. 7 is also the diagram of the arrangement represented in Fig. 8. At point 1 the e. m. f. is E_0. In the coils inserted in the line between points 1 and 2, the e. m. f. $i_0 z$ is consumed, so that at point 2 the e. m. f. is $n\,E$. The same e. m. f. is at point 3. In the coils, inserted in the line between 3 and 4, the e. m. f. $i_1\,z$ is consumed, so that at point 4 the e. m. f. is E_1. Between points 2 and 3 a shunt is arranged so that $i_0 + i_1 = i_\infty$. This corresponds to the combination of the magnetomotive forces $n\,i_0$ and $n\,i_1$ to the total flux $n\,i_\infty$ in Fig. 7.

We, therefore, see that to formulate the boundary conditions for

the loaded conductor of the Reed type, as illustrated in Fig. 9, we can just as well formulate them for the arrangement represented in Fig. 10.

A long, uniform wire forms a loop $A\ B$. The whole length is $2\,l$, the distance between the transmitting end A and the receiving end B is therefore l. R, L, C represent the resistance, inductance and capacity, respectively, per unit length of the uniform wire (in ohms per mile, henrys per mile, and farads per mile, respectively). At equal distances, as shown in Fig. 10, Fig. $2k$ equal coils are inserted

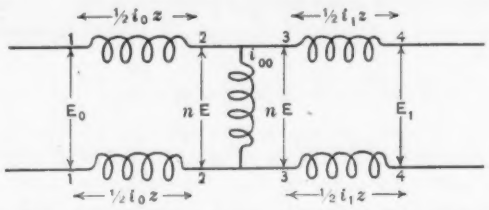


FIG. 8.—ARRANGEMENT EQUIVALENT TO THAT OF FIG. 6.

in series, each consisting of two halves, each half having the resistance R_1 (in ohms) and inductance L_1 (in henrys). There are, furthermore, k bridges across the line, each being a coil of the resistance R_0 (in ohms) and inductance L_0 (in henrys). Each of these bridges connects the middle points of two opposite series coils.

R_1, L_1, R_0, L_0 are related to the characteristic values of the transformers in the following way. R_1 is equal to one-half the internal resistance of either the primary or the secondary winding of each transformer. L_1 is equal to one-half the internal "true self-inductance" of either the primary or the secondary winding of each transformer. R_0 and L_0 are connected with the so-called "primary admittance" of the transformer, which is defined as the ratio of the exciting current to the primary counter e. m. f. If, in Steinmetz where N equals the frequency.

It therefore appears that the greater R_0 and L_0 the more is the loaded conductor of the Reed type equivalent to the loaded con-

FIG. 9.—REED SYSTEM.

notation, this primary admittance is $g_0 + j\,b_0$ *we have*

$$R_0 = \frac{g_0}{g_0^2 + b_0^2}$$

and

$$L_0 = \frac{b_0}{2\,\pi\,N\,(g_0^2 + b_0^2)}$$

ductor of the Pupin type. On the other hand, the smaller R_1 and L_1, i. e., the smaller the internal resistance and the true self-inductance of the primary and of the secondary winding of the transformer, the more is the loaded conductor of the Reed type equivalent to the loaded conductor of the Thompson type. Considered from a purely mathematical point of view, the Reed system can, therefore, be regarded as the general case, comprising the Pupin system and the Thompson system as special cases.

It must, of course, be assumed that there is no distortion of the waves, due to hysteresis or eddy currents in the iron cores of the transformers. If the arrangement, shown in Fig. 10, is used in practice, with coils without iron, such an assumption is superfluous.

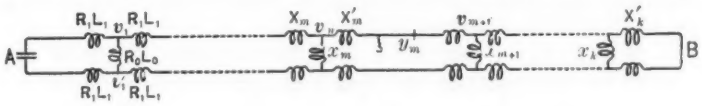


FIG. 10.—SYSTEM EQUIVALENT TO REED SYSTEM.

But in all cases when iron is used, either with the Pupin or Thompson or Reed system, special caution is necessary, as has been pointed out by Dr. Pupin.

VIII. CALCULATION OF THE REED SYSTEM.

Besides the values $R\ L\ R_0\ L_0\ R_1\ L_1$ defined in Section VII., the following notation may be introduced. Let be

$$Z_0 = R_0 + ip\,L_0$$

$$Z_1 = R_1 + ip\,L_1$$

The potentials at the terminals of the bridge m are v_m and v'_m and we have $v'_m = -v_m$. At the transmitting end A an e. m. f. of the type $E\,e^{ipt}$ is impressed upon the line, so that the potentials at the terminals of the transmitting apparatus are $\frac{1}{2}\,E\,e^{ipt}$ and $-\frac{1}{2}\,E\,e^{ipt}$.

Let y_m be the current at any point between coils m and $m+1$. Denote the distance of this point from the beginning of this uniform part of the line by ξ as shown in Fig. 10. The differential equation is the same as (1), the general integral the same as (2), namely

$$y_m = K_1 \cos M\,\xi + K_2 \sin M\,\xi \qquad (21)$$

where

$$M^2 = -C\,(-p^2 L + i\,p\,R);$$

if $M = \alpha + i\,\beta$, α and β have the same values as in (4).

Let V_m be the potential at the same point; it is of the form

$$V_m = N_1 \cos M\,\xi + N_2 \sin M\,\xi \qquad (22)$$

where, as before,

$$\frac{d\,N_1}{d\,t} = -\frac{M}{C}\,K_2$$

$$\frac{d\,N_2}{d\,t} = \frac{M}{C}\,K_1$$

Let X_m and X'_m be the currents in the coils between v_m and v'_m and $(V_m - 1)_{\xi = \frac{l}{k}}$ and $(V_m)_{\xi = 0}$ respectively, and x_m the current in the bridge m, as indicated in Fig. 10.

We have, as in Section V.,

$$x_m = \frac{2\,v_m}{z_0}$$

hence

$$X'_m = X_m - \frac{2\,v_m}{z_0}$$

for $m = 1 \ldots k$. We then get

$$(y_m)_{\xi = 0} = X_m - \frac{2\,v_m}{z_0} = K_1$$

$$(y_m)_{\xi = \frac{l}{k}} = X_{m+1} = K_1 \cos\frac{M\,l}{k} + K_2 \sin\frac{M\,l}{k}$$

$$(V_m)_{\xi = 0} = \left(1 + 2\,\frac{z_1}{z_0}\right) v_m - z_1\,X_m = N_1$$

From $\frac{d\,N_1}{d\,t} = -\frac{M\,K_2}{C}$ we get

$$ip\left(1 + 2\,\frac{z_1}{z_0}\right) v_m - ip\,z_1\,X_m = -\frac{M}{C}\,K_2.$$

We have, therefore, three equations between K_1, K_2, X_{m_1}, X_{m+1}, v_m, and can determine K_1 and K_2 as functions of X_m and X_{m+1}. If we introduce the values, found in this way, into equation (21), and if we write for abbreviation

$$\cot g\,Ms = \frac{ip\,C}{2\,M}\,(z_0 + 2\,z_1)$$

we get

$$(23a)\qquad y_m = \frac{X_m \frac{ip\,C\,z_0}{2\,M} \sin M\left(\frac{l}{k} - \xi\right) \sin M\,s + X_{m+1} \sin M\,(\xi + s}{\sin M\left(\frac{l}{k} + s\right)}$$

This equation is correct, for $m = 1, \ldots k-1$, while we have the following equations for $m = O$ and $m = k$;

$$(23b)\qquad y_0 = \frac{X_1 \cos M\,\xi + \frac{ip\,C}{2\,M}\,E\,e^{ipt} \sin M\left(\frac{l}{2\,k} - \xi\right)}{\cos\frac{M\,l}{2\,k}}$$

and

$$(23c)\qquad y_k = \frac{ip\,C\,z_0\,X_k \cos M\left(\frac{l}{2\,k} - \xi\right) \sin M\,s}{2\,M \cos M\left(\frac{l}{2\,k} + s\right)}$$

We have further for $m = 1, 2 \ldots k-1$,

$$v_m = \frac{z_0}{2}\,\frac{\sin M\,s}{\sin M\left(\frac{l}{k} + s\right)} \left\{ X_m \left(\cos\frac{M\,l}{k} + \frac{ip\,C\,z_1}{M} \sin\frac{M\,l}{k}\right) - X_{m+1} \right\}$$

and

$$v_k = \frac{z_0}{2} \frac{\sin M s}{\cos M\left(\frac{l}{2k} + s\right)} X_k \left(-\sin \frac{M l}{2k} + \frac{i p C z_1}{M} \cos \frac{M l}{2k}\right)$$

As

$$X'_m = X_m - \frac{2 v_m}{z_0}$$

we get for $m = 1, 2 \ldots k-1$,

$$(24a) \quad X'_m = \frac{\sin M s}{\sin M\left(\frac{l}{k} + s\right)} \left\{ X_m \frac{i p C z_0}{2M} \sin \frac{M l}{k} + X_m + 1 \right\}$$

and

$$(24b) \quad K'_k = \frac{\sin M s}{\cos M\left(\frac{l}{2k} + s\right)} X_k \frac{i p C z_0}{2M} \cos \frac{M l}{k}$$

The k boundary equations for the determination of the k unknown values $X_1 \ldots X_k$ are for $m = 2 \ldots k$ of the form

$$\left(\frac{\delta y_{m-1}}{\delta \xi}\right)_{\xi = \frac{l}{k}} - \left(\frac{\delta y_m}{\delta \xi}\right)_{\xi = 0} = -i p C z_1 (X_m + X'_m)$$

and for $m = 1$.

$$\left(\frac{\delta y_0}{\delta \xi}\right)_{\xi = \frac{l}{2k}} - \left(\frac{\delta y_1}{\delta \xi}\right)_{\xi = 0} = -i p C z_1 (X_1 + X'_1)$$

If we introduce the values of $y_0 \ldots y_k$ from (23) and the values of $X'_1 \ldots X'_k$ from (24) into these equations, we get the following set of equations for the determination of

$X_1 \ldots X_k$, where $m = 2 \ldots k-1$:

$$\left.\begin{aligned} (\sigma + 1) X_1 - X_2 &= D_0 - h_0 X_1 \\ (\sigma + 2) X_m - X_{m-1} - X_{m+1} &= 0 \\ (\sigma + 1) X_k - X_{k-1} &= -h_1 X_k \end{aligned}\right\} \quad (25)$$

In these equations h_0, h_1, D_0, and σ are functions of Z_0 and Z_1. As in the following we will only need the value of σ, I give only this, it is

$$\sigma + 2 = 2\left\{\left(1 + \frac{2 z_1}{z_0}\right)\cos \frac{M l}{k} + \left[\frac{i p C z_1}{M} \frac{z_0 + z_1}{z_0} - \frac{M}{i p C z_0}\right] \sin \frac{M l}{k}\right\}$$

The set of equations (25) is again of the same form as equations (6) in Section II., Part II., of Dr. Pupin's 1900 paper. The solution is, therefore, given by his equation (7)

(26)

$$X_m = \frac{[2 \sin \theta \cos (2k - 2m + 1)\theta + h_1 \sin 2(k-m)\theta] D_0}{h_0 h_1 \sin 2(k-1)\theta - 4 \sin^2 \theta \sin 2k\theta + 2(h_0 + h_1) \sin \theta \cos (2k-1)\theta}$$

where $\sigma + 2 = 2 \cos 2\theta$

or $\sigma = -4 \sin^2 \theta$

This represents the general solution of the equations for a loaded conductor of the Reed type, and we are now ready to apply this solution for investigating under which conditions a loaded conductor of the Reed type becomes approximately equivalent to a uniform conductor.

IX. EQUIVALENCE OF A LOADED CONDUCTOR OF THE REED TYPE TO ITS CORRESPONDING UNIFORM CONDUCTOR.

We can proceed in the same way as in Section VI., and can apply directly the results obtained by Dr. Pupin in his 1900 paper, Part II., Section II., namely, that when $\sin \theta = \theta = \frac{1}{2} \frac{l}{k} (a_1 + i\beta_1) = \frac{1}{2} \frac{l}{k} M_1$ nearly, this substitution transforms our equation (26) into the general equation of the current in a uniform conductor with impedances in the transmitting and receiving apparatus (equation (5), Part II., Section I., Pupin's 1900 paper).

The corresponding uniform conductor is, therefore, characterized in our case by the value of M_1, which is found as follows:

$$-4 \sin^2 \theta = \sigma = \sin \frac{M l}{k} \left[\frac{2 i p C z_1}{M}\left(1 + \frac{z_1}{z_0}\right) - \frac{2M}{i p C z_0}\right] - 4 \sin^2 \frac{M l}{2k}\left(1 + \frac{2 z_1}{z_0}\right) + \frac{4 z_1}{z_0}$$

If $\frac{M l}{k}$ very nearly $= \sin \frac{M l}{k}$, we get[1]

$$-4 \sin^2 \theta = \frac{M l}{k}\left[\frac{2 i p C z_1}{M}\left(1 + \frac{z_1}{z_0}\right) - \frac{2M}{i p C z_0}\right] - \left(\frac{l}{k}\right)^2 M^2 \left(1 + \frac{2 z_1}{z_0}\right) + \frac{4 z_1}{z_0}$$

Now, if we make

$$\sin \theta = \frac{1}{2} \frac{l}{k} M_1$$

we get[1]

$$-M_1^2 = -M^2 + 2 i p C z_1 \frac{k}{l} + \frac{1}{z_0}\left[2 i p C z_1^2 \frac{k}{l} - \frac{2M^2}{i p C} \frac{k}{l} - 2M^2 z_1 + \frac{4k^2}{l^2} z_1\right]$$

If we introduce the notation

$$\zeta_0 = R_0 \frac{k}{l} \text{ and } \zeta_1 = R_1 \frac{k}{l}$$

$$\lambda_0 = L_0 \frac{k}{l} \text{ and } \lambda_1 = L_1 \frac{k}{l},$$

where ζ_0 and ζ_1 have the same dimensions as R (ohms per mile) and λ_0 and λ_1 the same dimensions as L (henrys per mile), we get

$$(27) \quad -M_1^2 = i p C \left\{(R + 2\zeta_1) + i p (L + 2\lambda_1)\right\} + \frac{2}{\zeta_0 + i p \lambda_0}\left\{i p C (\zeta_1 + i p \lambda_1)\left\{(R + \zeta_1) + i p (L + \lambda_1)\right\} + \frac{k^2}{l^2}\left[(R + 2\zeta_1) + i p (L + 2\lambda_1)\right]\right\}$$

By this equation the "equivalent uniform conductor" is defined for the Reed system. To calculate the resistance and inductance of this equivalent uniform conductor separately, we must separate the real and the imaginary parts of the right side of equation (27). I will not give here the results of this calculation, as they are not necessary for the conclusions which I will draw from equation (27). First, I will show that this definition contains the definition of the equivalent uniform conductor of the Pupin type and Thompson type as special cases.

If $z_0 = \infty$, we get $-M_1^2 = i p C \left\{(R + 2\zeta_1) + i p (L + 2\lambda_1)\right\}$

i. e., in the Pupin system the equivalent uniform conductor has the same total resistance and inductance, as the loaded conductor.

If $Z_1 = O$, we get for the Thompson system

$$-M_1^2 = i p C (R + i p L)\left[1 + \frac{2k^2}{l^2} \frac{1}{i p C (\zeta_0 + i p \lambda_0)}\right]$$

This leads to the equations (16) and (17) in Section VI.

To simplify the equations, I will assume that L, the inductance per mile of the original unloaded conductor, is zero, which is approximately the case in ordinary telegraph and telephone lines. I will further assume the ideal case that the coils inserted in the line have the resistance zero, i. e., $\zeta_1 = \zeta_0 = 0$.

In this case, if the Pupin system is used the "equivalent uniform conductor" has the resistance per mile R and the inductance per mile $2\lambda_1$, i. e., the resistance has not been changed, while the inductance has been increased; the beneficial effect of the Pupin arrangement is due to this increase of inductance.

If the Thompson system is used, the "equivalent uniform conductor" has the inductance per mile zero and the resistance per mile $R - \frac{2}{C} \frac{k^2}{l^2} \frac{R}{p^2 \lambda_0}$, i. e., the inductance has not been changed, while the resistance has been diminished; the beneficial effect of the Thompson arrangement is due to this decrease of resistance.

[1] This supposition is necessary to get simpler formulas for the resistance and inductance per unit length of the "corresponding uniform conductor." In the case of the Pupin system it is fulfilled whenever Pupin's rule is fulfilled for the equivalence between the loaded conductor and a uniform conductor; if in Pupin's system the size of half the angular distance between two consecutive coils is nearly equal to half the angular distance itself, the angular distance relating to the wavelength in the "corresponding uniform conductor," the same is the case for the angular distance relating to the wavelength in the original unloaded conductor, because the wavelength is shorter in the loaded conductor of the Pupin type than in the original unloaded conductor. In the Thompson system the wavelength is greater in the loaded conductor than in the original unloaded conductor; in this case the above supposition to which this foot-note refers is a separate condition. Whether in the Reed case this supposition is a separate condition or not, depends upon the value of the wavelength in the loaded conductor of the Reed type, compared with the wavelength in the original unloaded conductor.

If the Reed system is used, we find from equation (27) that the inductance per mile of the equivalent uniform conductor is

$$2\lambda_1\left(1+\frac{\lambda_1}{\lambda_0}-\frac{2k^2}{l^2}\frac{1}{p^2C\lambda_0}\right)$$

and the resistance per mile

$$R\left(1+2\frac{\lambda_1}{\lambda_0}-\frac{2k^2}{l^2}\frac{1}{p^2C\lambda_0}\right)$$

Hence, the resistance becomes smaller than R and the inductance becomes positive, if

$$1+\frac{\lambda_1}{\lambda_0}>2\frac{k^2}{l^2}\frac{1}{p^2C\lambda_0}>2\frac{\lambda_1}{\lambda_0};$$

it is evident that λ_0 must be chosen greater than λ_1 or L_0 greater than L_1. It will be seen that with the Reed system it is possible to accomplish both purposes—increase of inductance and decrease of resistance of the transmission line.

I have considered the ideal case of $L=0$, $\zeta_0=0$, $\zeta_1=0$, because the formulas become most simple and allow to show plainly the relations between the Pupin system, the Thompson system, and the Reed system. The principal purpose of this paper has thus been accomplished.

To sum up, the general theory of the Thompson system and the Reed system has been developed in a way analogous to that used by Dr. Pupin for the calculation of his own system. The formulation of the boundary conditions in the three cases of the Pupin, Thompson and Reed systems leads to analogous sets of equations, and this is the reason why the comparison of the loaded conductors of the Pupin, Thompson and Reed types with their "corresponding uniform conductors" can be made in the same way in the three cases and leads to analogous results; but the definition of the "corresponding uniform conductor" is essentially different in the three cases. While in the case of the Pupin system the total resistance and inductance of the corresponding uniform conductor, is equal to the total resistance and inductance of the loaded conductor, the definitions of the resistance and inductance per unit length of the corresponding uniform conductor for the Thompson system and the Reed system are given by the equations (16), (17) and (27).

The resistance and inductance per unit length being defined as functions of the frequency, I have restricted myself to the theory of the transmission of a single sine wave of given frequency. From the difference of the definition of the "corresponding uniform conductor" in the three cases, results the essential difference between the three systems. A loaded conductor of the Pupin type behaves like a uniform conductor with greater inductance per unit length than the original unloaded conductor; a loaded conductor of the Thompson type behaves like a uniform conductor with smaller resistance per unit length than the original unloaded conductor; in a loaded conductor of the Reed type both these beneficial effects may be combined.

As far as long-distance telegraphy with sine waves of a given frequency is concerned, the three systems discussed enable one to diminish the attenuation in the transmission of a given amount of energy over a line of given copper, or to save copper with the same attenuation. For telephony the question arises, How far the attenuation depends upon the frequency in the Thompson and the Reed systems? or, in other words, how far the circuit is distortionless for practical purposes? It would be interesting to investigate this in numerical examples, but the discussion of this question is beyond the principal purpose of this paper in which I wished to restrict myself to an exposition of the general principles of the problem.

Rotations from Electric Sparks.

BY ALFRED G. DELL.

IN the following I will treat of the electric sparks coming from the secondary of an induction coil in producing rotations of a horizontal disk, the forces being frequently only discharges of the sparks. I will first give some experiments made with a mica disk coated with shellac and rotating in a horizontal plane, the forces being spark discharges, of a maximum length of ¾ inch, reduced to 9-16 inch, and passing under the disk on the one side.

I found the humidity of the atmosphere had an astonishing effect on the rotations of such disks, the moisture settling on the disks and about the electrodes, and also direct effect on the charges on the disks, and the discharges from the points under the disks. When a disk was made sensitive enough both as regards its freedom of rotation and balancing, and everything else made perfect, it always started, if left alone, from the + to the — direction; and if started from — to +, it rotated in that direction without reversal.

If the humidity of the atmosphere was, say, 48 per cent. the disk would rotate only in the one direction from + to —, but it was generally possible to obtain a rotation in the opposite direction with a starting velocity nearly equal to its final one, if the sensitiveness of the disk was increased, which is generally possible. As the humidity is decreased by putting the disk in a tight oiled and lacquered wooden box with glass sides and containing calcium chloride, the starting velocity required to obtain a rotation from — to + was diminished until, as far as I have gone in removing the humidity, it required only the slightest impulse to set it rotating — to +, while at the same time the rotation from + to — was increased. The final constant velocity of rotation was a little greater from + to — than from — to + in all cases. In my search for a cause of the above rotations, I had two theories, one of which was repulsion and attraction of charges on the disk between side discharges and direct ones from the points; and the other that small particles or atoms were torn off of the electrodes and propelled against the disk. Knowing that there would be charges on the disk, and that there would be repulsion and attraction between them and the discharges from the points, I accepted the former as the true theory, coupled with a shifting forward or backward of the charges on the disk by its rotation, the shifting depending in direction upon the direction of rotation.

I am quite sure that if nearly all moisture were removed from a box containing a disk, it would bring the two forces to an equalization; and if all were removed the minus would possibly predominate, and a very rapid rotation from rest from — to + would be obtained, I have a sensitive disk in a very tight box, which has contained calcium chloride for several weeks, and with it I am never quite sure in which direction it will to a certainty rotate from rest; the slighest inducement will send it from — to + direction. The smallest amount of moist air let into the box at once determines with more certainty the rotation from rest from + to —.

Right here some little light is thrown on the two discharges in a Geissler or Crookes tube. As the air with its moisture is being removed from the tube by a pump or otherwise, the cathode discharges begin to come into prominence, in the same manner as in the case of the disk when the moisture is being removed, which is an effect separate from that of the vacuum in the tube.

The question may be asked, Does not the disk sometimes, while moisture is present in the air, start to rotate? My answer is, there are sometimes, when the humidity of the atmosphere is high, indications of the forces being present by the disk very slowly rotating from + to —, providing there is no moisture on the disk or anywhere about it; these rotations become very erratic or cease entirely, and are only momentary impulses acting now and then, and produce no genuine constant rapid rotations. With moisture present I have found it impossible to make any experiments.

Sometimes the disk with ordinarily low humidity, will start from — to + and rotate, but I have always found it was from unnaturally tarnished points, produced by reversing the primary current, faults in the disk, a polarizing battery or a spark-gap in series somewhere, a broken wire for instance; with a spark-gap in series it nearly always, in fact, under certain conditions always, started from — to +, depending somewhat upon the length of the gap and degree of humidity. See a description of a Crookes tube requiring a spark-gap in series to produce Röntgen rays, printed in the *Electrical World*, Oct. 2, 1897.

It has been stated that the velocities of ions of the electric wind have the ratio of the — to the + of 1.31 for air in the same field. If that ratio is thought to hold in ordinarily dry air, I do not see how the disk could start to rotate from + to — unless the masses of the + ions were greater than those of the —, or unless the disk had to be started from + to — to make it rotate, which is not a fact, as it has to be started from — to +.

It has been stated, "It has been known for some time that a charged or electrified body resists having its motion varied, by reason of the magnetic disturbance which such variation effects, and which pulls upon the electric charge in such a manner as to oppose the change, etc." If that theory is to be applied to the rotating disks it would indicate something in the nature of a resistance to a change of the direction of the motion, but a resistance could not increase the velocity.

The changes of the rotation of the disk when in a tight box with calcium chloride are remarkable. I will describe in full the changes with a disk which I knew was sensitive enough to rotate well in either direction. I placed it in the box with calcium chloride, the humidity being about 60; it would not rotate, but after a few days I detected a slight rotation from + to —; and after some further time a rotation fairly well from + to —, and a long rotation from — to +, when started rapidly, but a final reversal; after a little while longer an increased rotation from + to — and a constant rotation from — to +, with a large starting velocity almost equal to its final velocity; after a little while longer a rapid rotation from + to —, and a rotation from — to + with a still smaller starting velocity, and so on, until finally a rapid rotation from + to —, and a rotation from — to + with but a slight impulsive force required in that direction; and now any slight imperfection (the forces being nearly balanced) in the disk began to make their appearances, such as a place from which, when the disk started of itself while at rest, is swung around to and fro as if undecided in which direction to go, the place acting as if it had springs at both sides, the space of oscillation in this case being about ½ inch on the circumference; it would generally finally rotate from + to —, but sometimes would obtain swing enough to send it the other way, and if it once passed one of the points of obstruction or faults in balancing, that determined the rotation, it having a start sufficient to send it on its rounds with an accelerating velocity to a final constant one. Its peculiarities can only be understood by following it up at intervals, as the moisture is taken up by the calcium chloride.

The "magnetic disturbance" and no other might be present; where in the above description, the disk rotates for a long time from — to +, and then reverses; but there is a driving force present also, which is shown by its subsequent action, which makes it impossible to distinguish the effects of one from the other, if the magnetic effect is really present, and retards the rotation. It may be asked, Cannot something be seen on the disk above the sparks? and my answer is, Yes, there appears a long line of flickering light moving to and fro on the disk right above the sparks; whether it is a visible true rapidly dissipating charges on the disk, or only the light which would be anticipated from the sparks, I am unable to state, and do not know as yet of any way to determine the point; it may be both. I believe the humidity in the air and collected on the disk very rapidly dissipates the charges on the disk, and also affects the discharges of the points in the same manner, but to a somewhat smaller extent.

Continued heat has some decided effects, but I have some doubts whether it has any direct effect on the discharges. The heat reduces the velocity of rotation, and to some extent increases the starting velocity required to send it in rotation from — to +. A disk rotated either way when the temperature in the room was 94 degs. F., but with a reduced velocity over that when it was cooler. I tried various means to determine whether there was any direct effect from heat, but as yet have not succeeded. Some effects connected with it are extremely difficult to account for, being so intermixed with other known effects, and thus in a manner covered up.

It may be asked, At what greatest distance from the points will the disk rotate? I will answer that by stating that I made an arrangement where the axle of the disk was magnetized and hung by magnetism from another piece of steel magnetized in the opposite sense. The arrangement was constructed so I could raise or lower the disk without disturbing it, even while in rotation. I found I could obtain rotation from the side discharges of 1½-inch sparks with the disk raised as much as ¾ inch from the points. This construction is very easy, and will rotate well. Those with jeweled bearings are more difficult to make, having to be well balanced to rotate well; but when perfect, they will furnish rapid rotation.

The following is one of the curious actions of a disk in a tight box with calcium chloride. I will first describe a part of the construction of the present arrangements. I have two of the disks in tight boxes. The one has the electrodes of a narrow brass plate with raised sharp points under the disk near the circumference. Both electrodes are placed on the outside of the disk, extending only slightly under the disk. They rest on cardboard covered with shellac, to keep out dampness when the box has to be opened, and there are two pieces of tinfoil at an opposite diameter of the disk. The cardboard is cut away between the sparker and elsewhere, so that if any dampness should collect in it the impulses from the one could not pass that way in going from one electrode to the other. The tinfoil is connected to the leading-in wires. Nothing except what has been described was noticed with this arrangement.

The other one is made the same way, but the electrodes are fastened direct to the leading-in wires. I fastened strips of thin mica on the pieces of cardboard with shellac covering the whole of the two pieces of cardboard, and extended the mica some little under the disk. With this arrangement I encountered an entirely new phenomenon. When I connected it up with the coil and started the current, the disk started to rotate from + to —, which is the direction it always started when not fast; it rotated rapidly for a while, but finally rapidly slowed up and stopped still, started over again, repeated it several times, and then suddenly started from — to +, and rotated in that direction, stopped and started again, reversed in direction, and finally came to a long stop. On pressing a piece of hollow rubber fastened on the end of the glass tube which passes through one side of the box containing the disk, with the other end of the tube above the disk I found I could budge the disk but little. It appeared to be nearly fixed as regards the air from the tube. On leaving the disk remain inactive for some time, at least a half an hour, trying it frequently, on pressing the rubber slightly the disk started to rotate, showing the tube acted properly. I found when the current had been turned off it would sometimes but not always start in that direction and rotate, if the current was turned on again, although the disk had been idle for some time, but still nearly unmovable. If when it stopped it had been rotating from + to —, it would often start in that direction, when the current was again turned on; and in both cases would go through something like the same motions that it did before the current had been turned off.

The rotations are all rapid ones. When the disk is fast, by pressing the rubber on the end of the tube, it will start from — to + when the coil is started, providing the rubber is pressed hard and rapid; the wind assists the — side. While rotating from + to — the motion could not be reversed by the rubber. This is not due to the disk or electrodes, as I have used them frequently without the mica under the electrodes, and obtained the ordinary results

The blower acts well, as shown, when there has been no connection with the coil for some time. I again tried the arrangement with heat for some two hours, but it had not any perceptible effect. It is the mica under the disk that causes the strange phenomenon. It acts as if condensers were present. It is the first time I have obtained such peculiar results, and give the experiments for what they are worth. The parts under the disks have been thoroughly examined with a lens for any obstructions raised by the electrical discharges.

The perpendicular components of the repulsive forces are easily discovered from experiment. The top of the axle of a disk is always loose in its jewel, and when allowed very lightly to rest over the spark points, as soon as the first discharge takes place the disk straightens up and will rotate with but little falling over again towards the points, providing the disk is well constructed. I have been unable to discover from experiment anything relating to the attractive forces. It seems reasonable to suppose there must be some attractive forces present also, but not to the same extent as the repulsive.

For the disk to rotate well, it appears from experiments that the points must be exactly alike, but if there is slightly more metal on one side than the other, it makes no difference. When a disk is first arranged I always determine whether it will start and rotate, as near as I can distinguish, with the same velocity from + to —, whether the right or left hand-point is the positive one. I generally find that whenever there is a difference in the velocities, there is a difference in the points, which I could discover by the use of a lens. Any foreign matter on a point interfered with rotation.

I find that with the use of shifting cardboard pieces of large size covered with shellac and placed under the electrodes and disks, there is a slight condensation effect, such as is discovered to be of such great prominence with the use of mica or glass; it is so slight, however, that I would not have noticed it at all if I had not anticipated it and looked for it. The effect shows in a slight swinging backward and forward of the disk after it has been rotating for some time, and has come partly to rest; after the exciting influences of the coil have been removed it quickly disappears.

The after-excitations seem to come principally from the points discharging on the disk some of the accumulated charges on the material under the electrodes; and the electrostatic lines of force between the charges on the mica or glass under the electrodes and disk act like elastic rods standing erect perpendicular to the surfaces; they resist being bent by the forced rotations of the disk, and

when bent return or attempt to return, and failing take hold of the disk in new places, the electrostatic lines extending from the mica or glass to the disk, and temporarily holding thereto.

There appears also at times to be a continuation of the rotations after the excitations of the coil have been stopped, although this is difficult to determine for a certainty; but I am almost positive that at times the disk rotated longer than it should from its ordinary momentum. The charges on the mica or glass last from ½ to 5 or 6 hours, depending upon the degree of humidity. The lower the humidity the longer they last, which is indicated by the resistance of the disks to the slight wind from the glass tube used to change its direction of rotation. To construct boxes that would keep out all moisture, they would have to have glass walls entirely.

When once the disks rotate well in both directions the boxes containing a small quantity of calcium chloride, they will rotate at all times when excited by the coil, and last for months; but there are always changes in their velocities of rotations from the effects of variations of moisture, heat, etc.

If there are any who repeat my experiments with the rotating disks I would suggest that they will, if convenient, allow the light from an electric arc to fall on a disk and its spark-gap, and note the results, if any, as to changes of velocities, etc. The light from a gas jet seems to increase the velocities.

In the *Electrical World* of Oct. 2, 1897, I described a Crookes tube which, when attached to the terminals of the secondary of an induction coil, required a spark-gap in series to produce Röntgen rays. Without the spark-gap there was no light in a fluoroscope. With the spark-gap in series, the brightness of the light obtained depended upon the length of the gap. The wider open the gap the greater the light, providing it was not too wide open to allow sparks to pass. I also described a peculiarly colored cloud of light around the anode with no gap in series, which gradually disappeared when the gap was being opened. It is well to compare experiments. I have found on numerous occasions—in fact, it is a natural effect, occurring always with one certain disk I have—that a spark-gap in series or even a poor connection, such as would hardly answer with a battery current, that the — side of the disk which is the more favorable side, will cause it to start from perfect rest and rotate from — to +. The effect of the gap is always in that direction, although sometimes with some disks it fails, its effect not being strong enough to reverse the starting direction. It would seem that the cloud of light around the anode of the X-ray tube mentioned above must have been anode spark discharges, which spark discharges must be suppressed to produce Röntgen rays; the anode discharges appearing in the tube as charges only, and not spark discharges across the tube or away from the anode, so as to meet the cathode discharges in space.

I will also refer to the activity of Röntgen rays often produced in Crookes tubes by the partial removal of the remaining humidity by absorbents, which is in agreement with the humidity effects on the rotating disks as described. In heating a Crookes tube, as is sometimes done, to make it more conducting, is it not likely that the heat frees the remaining moisture to some extent collected on the glass walls and electrodes, and thus raises its conducting conditions?

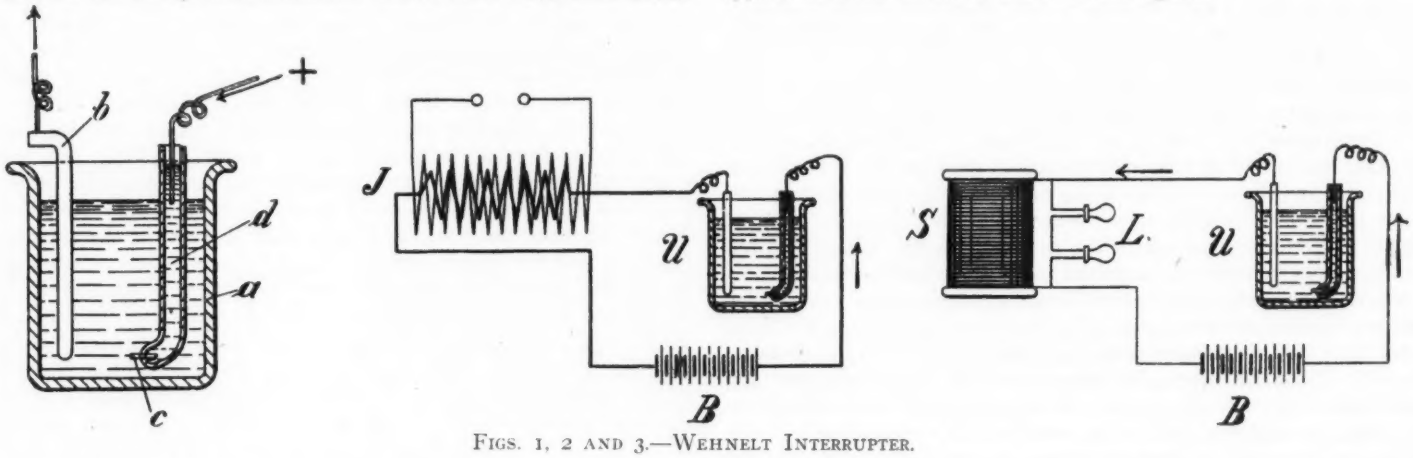
I do not think it will do to compare the phenomena of discharges in high-vacuum tubes with those that would take place in inter-stellar space, as the absence of all heat and humidity would have to be taken into account in celestial space. It must be remembered that disk arrangements can be constructed that will rotate, acording to my experiments, only from + to —, it making no difference on which side of the disk the + electrode is, or if for any rotation from — to + there will have to be a large starting velocity, no difference what the obtainable low humidity is. Such arrangements do not rotate with sufficient freedom to run well from — to +.

The Wehnelt Interrupter.

A United States patent was issued March 19 to Arthur Wehnelt on the electrolytic-current interrupter now well known by his name. A description of this interrupter first appeared in the *Elektrotechnische Zeitschrift* of Jan. 26, 1899, and led to a widespread interest in the device, which has scarcely been justified by the practical results obtained from it. The specification of the patent is so free of Patent Office jargon that we reprint it in full below:

When an electric current is sent through an electrolyte by means of two electrodes of unequal surface area under a voltage largely surpassing the polarization tension in opposite direction, the well-known phenomena of light and heat occur. Lagrange and Hoho, *Lum. él*, 1894, Vol. 52, page 113, and Vol. 51, page 165, based recently an electric-welding process upon this occurrence. They called the smaller electrode manifesting the generation of light and heat the "active" electrode. The following publications treat of this subject: Franz Richarz, *Wied. Annals* 39, pages 67 and 201, 1890; C. Fromme, *Wied. Annals* 29, page 187, 1886; Koch and Wüllner, *Wied, Annals* 45, pages 473 and 759, 1892. The latter gentlemen mention that they heard under the above-stated conditions when a telephone was inserted a purring sound and they deduce therefrom and also from the noise manifesting itself simultaneously with the phenomena of light and heat that the current passing the apparatus is not constant, but oscillating. Closer study by me into this phenomenon has resulted in the discovery that the current is not only oscillating, but completely interrupted, reaching as high a speed as 1700 breaks in a second.

For the experiments hereinafter described the apparatus represented in Fig. 1 was employed. Into a tumbler *a*, filled with diluted sulfuric acid (preferably of 20 to 25 degs. Baumé), a lead plate *b* and a platinum wire *c* are dipped or submerged, the latter being fused into a glass tube *d*. The glass tube is filled with mercury for the purpose of conducting the current to the platinum wire *c*. It proves to be the most advantageous to pass the current through the apparatus in the direction shown in the figure.



FIGS. 1, 2 AND 3.—WEHNELT INTERRUPTER.

The efficiency of the interrupter was hitherto tested, as stated below:

First, on inductors of a length of spark of 2, 15, 30 and 50 cm the connection is represented in Fig. 2. *J* designates an inductor; *U* the electrolytical interrupter, Fig. 1, and *B* an accumulator battery or other source of energy (of at least 14 volts).

The discharge of the secondary coil of the induction coil has a peculiar character always more arc-like under normal current owing to the high number and the regularity of the interruptions or breaks. The length of sparks is the same as the same induction coil gives under equal current with the ordinary interrupters. By increasing the tension and the intensity of the current the effect of the induction coils can be materially enhanced without being injurious for the new interrupter—as, for instance, for platinum interrupters (in which the contacts will burn away). Whatever enhances the self-induction in the circuit increases the efficiency of the apparatus. The intensity of the current grows with the increase in the surface

of the active electrode. The number of the interruptions grows with the increase in tension or voltage.

In order to obtain easy change in the surface of the active electrode, the arrangement represented in Fig. 4 is appropriately made. The platinum wire *c*, forming the active electrode, is passed through a porcelain plug *h* in this arrangement and fastened on a rod *e* of

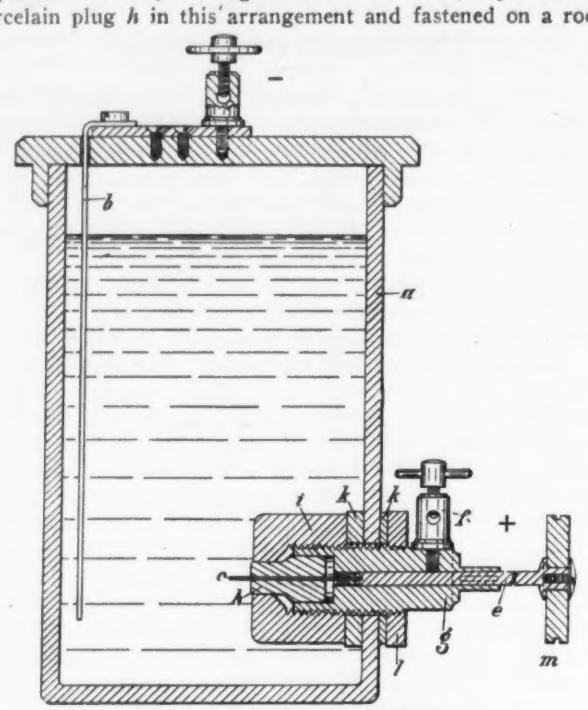


FIG. 4.—WEHNELT INTERRUPTER.

brass or similar material. The latter is adjustable in the box *g*, made of brass or similar material, said box being provided at its inner extremity with a sleeve *i*, of hard rubber or the like, which sleeve is screwed on and passes over the porcelain plug *h*. At its exterior extremity the box is provided with a check-nut *l*. The packing of this box against the wall of this vessel *a* takes place by means of the two rubber plates *k*, which are pressed together by the nut *l*. On the box *g* is fixed the terminal *f* for the positive pole. The rod *e* is provided at its rear extremity with a disk *m*, by means of which the platinum wire *c* can be pushed out from the porcelain plug *h* as far as may be desired, so as to increase thereby the surface of the active electrode at will.

Second. When inserting incandescent lamps *L* parallel to the coil *S*, between *a* and *b*, Fig. 3, which was fed in rotation by the electrolytic interrupter *U*, by means of the battery *B*, with 12, 24, 48 and 96 volts, the following bright illuminations took place: When using 12 volts, a 30-volt lamp; when using 24 volts, a 63.5-volt lamp; when using 48 volts, a 120-volt lamp; when using 96 volts, two 120-volt lamps. Electrometrical measuring of the terminal voltage showed that it always amounted to more than double the battery voltage.

Third. For converting direct current into alternating current for optional up-and-down conversion of the latter two converters were used, 100 volts for primary and 1000 volts for secondary alternating current. These converters, fed by means of the new interrupter with a 100-volt direct current, do not yield secondarily 1000 volts of alternating current, but 2000 volts and over of alternating current. When converted down again, the low voltage or tension coil of the second converter yielded 200 volts. Many further tests with smaller converters proved the eminent usefulness and a good efficiency (up to 70 per cent) of the interrupter for converting purposes.

Two claims accompany the patent, as follows:

1. An electrolytical interrupter for direct currents comprising two electrodes, a vessel containing an electrolyte into which the electrodes dip, said electrodes being of a surface of unequal size, the anode serving as the active electrode and their terminal voltage being higher than the polarization tension.

2. In an electrical interrupter, the combination of the vessel containing an electrolyte, the two electrodes dipping therein, the active electrode being adjustable and means for adjusting the same consisting of the rod *e* connected with the electrode, the insulating block *h* through which the electrode extends, the box *g* through which the rod *e* extends, means for holding the insulating block to the box, means for holding the box to the vessel and means for electrical connection with the rod.

The Distribution and Conversion of Niagara Current at Buffalo, N. Y.*

By Henry Gordon Stott.

BEFORE proceeding to the subject proper of the paper a brief description was given of the apparatus and lines generating, transforming and conveying the current from Niagara Falls to the terminal house at the city limits of Buffalo, where the overhead lines terminate and the underground distributing system for the various purposes to be hereafter described, begins.

The power received in Buffalo originates at the well-known plant of the Niagara Falls Power Company at Niagara Falls, N. Y., in water-driven turbines direct connected to 5000-hp two-phase, 2200-volt, 25-cycle generators. Ten of these generators are now installed, and a new wheel pit is being excavated on the south side of the surface canal, parallel to the present power house, for 12 more generators of the same size, which will give an ultimate total capacity of 110,000-hp; and it is a very safe prophecy to say that every horsepower of it will be sold as fast as the turbines and generators can be installed, as the present installation of 50,000-hp is all contracted for, and already many customers find themselves in the position of Oliver Twist, and with no better results.

The 2200-volt, two-phase currents are conducted into the transformer house, where, after passing through time element overload circuit breakers, they enter two distinct banks of step-up transformers of the air-cooled type, of an aggregate capacity of 12,000 kilowatts, which are arranged in pairs for the two-phase, three-phase connection at the same time to change the pressure to 11,000 volts. Within a couple of months the secondaries, which are now in multiple, will be connected in series to give 22,000 volts as originally intended.

The 11,000-volt, three-phase currents from the secondaries of the two banks of transformers are brought directly out in cables on large special porcelain insulators set in iron fixtures in the air chamber, and then on the regular helmet type porcelain insulators on timbers on the wall. The lightning arresters are of the usual multi-gap type, with reactive coils in series, and in a second type with an additional check to the current in the shape of carbon resistances to prevent the live current following the lightning discharge.

The two three-phase, 11,000-volt circuits running on the same pole line to Buffalo, each consist of three bare stranded copper cables of 350,000-cm area, forming equilateral triangles on each side of the pole, the sides of the triangles being 3 ft. In the run of 23 miles to Buffalo, the lines are transposed five times in order to equalize and minimize the inductive drop on all phases, and at Tonawanda where a branch line is taken off for Tonawanda and Lockport, lightning arresters are installed of a type similar to those used at Niagara Falls and Buffalo. During the first two years' operation of this line, iron guard wires grounded at every alternate pole were used for protection from lightning, but so much trouble was caused by them falling on the lines that after striking a balance between the supposed protector and the known trouble, the result was so everwhelmingly against the former that the guard wires were taken down, and the interruptions due to line trouble very materially reduced. The remaining trouble on this part of the system was almost exclusively due to the ever-present boy, who speedily discoverd that by a little dexterity in the manipulation of an old piece of iron wire or hoop he could produce brilliant Fourth-of-July effects at will. The cables were, at this time, only 18 inches apart, and an arc once established would travel backwards along the line with ease until the circuit breakers eventually opened at the Falls. This trouble was remedied very effectually by separating the cables 3 ft. apart, as at present, and at the same time arranging them so that they formed a triangle with the apex below instead of all being on the same plane as formerly.

At the terminal house situated at the city limits of Buffalo the lines now terminate in a common set of bus-bars, and to these bus-bars are connected the five three-conductor lead-covered cables which lead to the various sub-stations.

Simultaneously with the increase of line pressure to 22,000 volts there will be installed in the terminal house six 2250-kw step-down transformers of the oil and water-cooled type, reducing the pressure to 11,000 volts for distribution in the underground cables.

A third line is now being built from Niagara Falls to the terminal house, following a different route, in order to give greater security of service, but as the present pole line is built with very heavy

*Abstract of a paper read before the American Institute of Electrical Engineers, New York, March 22, 1901.

poles 90 ft. apart, no great anxiety is felt as to the possibilities of even Lake Erie zephyrs combined with sleet affecting it.

CONVERSION.

The 11,000-volt, 25-cycle, three-phase currents distributed to the seven sub-stations in Buffalo are manifestly unfit for use in the supply of power or light without transformation in the former and conversion in the latter case, as 25-cycle is much too low a frequency for arc lighting, which promises to displace incandescent lamps to a great extent in the near future.

In discussing the various means employed to make this power available to the customer, the paper begins with the simplest and then proceeds to the more complex. The simplest and most efficient method is evidently to reduce the pressure by means of static transformers of large capacity and high efficiency and deliver three-phase 2200-volt current to the various customers by means of a secondary network of cables. This is done in sub-stations Nos. 1, 2 and 3, where 2200-volt, three-phase currents are delivered by underground and overhead cables to customers for use in malt houses, grain elevators, machine shops, dry docks, bakeries, tanneries and all sorts of manufacturing establishments to the extent of about 4000 horse-power. This power is utilized in the above places chiefly by means of induction motors, some of which receive the current directly at 2200 volts, but in the majority of cases at a reduced pressure of 440 or 220, the reducing transformers being supplied by the customer. For grain elevators, in which a large amount of fine dust of an explosive nature is present, the induction motor presents an ideal solution of the power problem, as the safety and controlling devices can be located in a separate building, so that no spark can cause an explosion or fire. The efficiency of transformation with this system is evidently that of the transformers only, which in sizes of 250 kilowatts and upwards is from 97.5 to 98.3 per cent at full speed.

The largest user of power in Buffalo is the International Traction Company, which receives a total of 7000 horse-power in five sub-stations—No. 1, Cold Springs, Walden Avenue, Eagle and Jefferson Streets, and Elk and Seneca streets—where the power is distributed to their 550-volt direct-current feeders after being transformed from 11,000 volts to 375 volts and converted in rotary converters to 600-volt direct current.

An interesting comparison is the relative efficiencies and cost of static transformers and rotary converters as against motor generators receiving the 11,000-volt current direct into the motor, and converting it into 600-volt direct current by means of a generator coupled to the same shaft, and is given in the above table.

EFFICIENCIES: 200-KW UNITS.

	Transformer.	Rotary.	Combined.	Motor.	Generator.	Combined.
Full load.	97.5	93.0	90.67	95	92	87.4
¾ load.	97.1	92.5	89.81	94	91	85.54
½ load.	96.0	90.0	86.40	92	88.5	81.42

From this table it will be seen that the transformer and rotary converter give 3.27 per cent at full load, 4.27 per cent at three-quarter load and 4.98 per cent at one-half load better efficiency than the motor generator set.

The investment shows a saving in favor of transformers and rotary converters of about 19 per cent, so that for purposes such as railroad work, where no great refinement of regulation is required, the rotary is beyond doubt the best and most economical.

At the sub-stations, the incoming current enters a three-pole oil switch, which is known as an emergency switch, and from there branches to several oil switches, each of which controls the primaries of three 150-kw static air-blast transformers connected in delta; the secondaries, also delta-connected, go direct to the collector-rings of a 400-kw rotary converter, so that the three static transformers and rotary converter form one unit, being, in fact, started from the direct-current end and synchronized by means of small potential transformers on the 11,000-volt primaries.

To provide for the emergency of a total shut down of the power circuits, those sub-stations which have no storage battery auxiliary from which direct current may be got for starting the rotaries, a small motor-generator set is installed, consisting of a 30-hp induction motor direct connected to a 20-kw, 600-volt direct-current generator. This set is supplied with alternating current by means of a three-phase oil-cooled transformer, reducing the pressure from 11,000 to 375 volts; as soon as the power is on the cables the induction motor is started, the small direct-current generator is connected to the bus-bars and one of the rotaries started and synchronized in the usual way, after which the motor generator set is shut down and the remaining rotaries started from the first. From the five sub-stations distributing power to the direct-current feeders great economy of distribution is obtained and an equality of pressure at practically every point of the system, which would be practically impossible with a single plant with 550-volt feeders covering the same distance. Storage batteries are installed at sub-stations No. 1, Cold Springs and Eagle and Jefferson, having a total capacity for 1½ hours of 2400 horse-power at 575 volts. They are used principally to help carry the peak load between 5 p. m. and 6.30 p. m., and to take up part of the extreme fluctuations of load through differentially wound boosters.

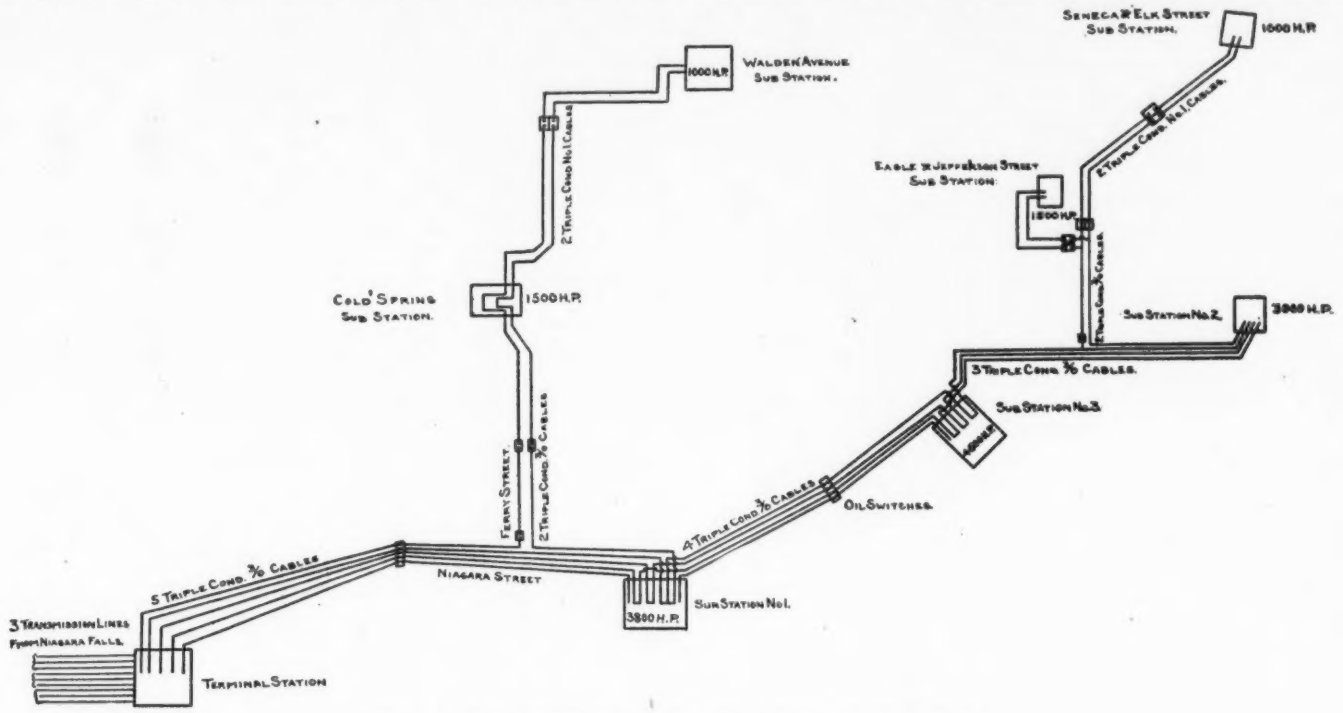


FIG. 1.—ARRANGEMENT OF 10,000-VOLT CIRCUITS IN BUFFALO.

We now come to the last and most interesting plant connected to the transmission system in Buffalo, viz., that of the Buffalo General Electric Company, the transformer house of which is marked "Sub-station No. 3" in Fig. 1, and in which 4000 horse-power is received from the power company, and after being transformed to 360 volts is converted by means of motor-generator sets, rotaries, etc., into four different kinds of service—constant continuous current for street arc lighting, 60-cycle quarter-phase current for incandescent and arc lighting in the more remote districts, three-wire, 220-volt continuous

current for the down-town district, and 550-volt continuous current for power to motors, elevators, etc.

The transformer house, built as an annex to the main tsation, has 12 250-kw transformers, reducing the three-phase, 11,000-volt currents to three-phase 360 volts. The transformers are arranged in two rows instead of three, as usually, in order to facilitate the rapid exchange of one in case of trouble. By arranging them in this way the transformer has only to be raised half an inch by the hand-crane and then run out of the way to make room for the spare one, an operation requiring only an extremely short period compared to that necessary to lift the transformer over the others. The transformers stand over a brick air chamber 30 by 9 by 7 ft. high, into which three 2-hp. induction motors direct connected to air-blowers force cool air, giving an even pressure of about half an ounce in all parts of the chamber. Access is had to the air-chamber through double air-tight doors, so that a man can work on the terminals or connect up a new group without interfering in any way with the air supply. Iron shelves on the outside of the brick walls of the air-chamber form supports for the primary cables leading to the switchboards on the one side and for the secondaries on the other, giving wide separation for safety.

The transformers are connected to the primary and secondary switchboard panels by rubber insulated and lead covered cables; each transformer is wired single-phase to the panels, the delta connection being made after passing through spring expulsion type aluminum fuses on the primary side, and ordinary long break aluminum fuses with barriers on the secondary side, so that in the event of a transformer burning out it will cut itself out of circuit without affecting the other two of the same group.

The secondary current after going through the usual recording and indicating instruments, terminates in three heavy copper bus-bars, extending the full length of the secondary board, to which are attached the cables bringing the current into the main building of the Buffalo General Electric Company.

In adopting the secondary voltage of 360, a number of points were taken into consideration, the principal one being that a large and healthy day load in 550-volt direct-current motors was being supplied at the same time steam was used for motive power, and could not well be discontinued, so that voltage was adopted which would permit of rotaries being run without any further transformation. This pressure besides being very safe for cables and motors, is a very economical one to build for, as it permits of the use of bar winding on all sizes, and as all motors are of the revolving field type, the question of carrying heavy current in the collector rings was left out. The only additional cost due to the low pressure was in the cables within the plant, and this was more than balanced by the saving in a further transformation for the 550-volt rotaries and in the additional safety of bar winding versus wire.

The power house is a building 91 by 91 ft., having a row of columns down the center, each half of the building being spanned by a crane traveling the full length with transfer points from one crane to the other.

In this building having 8281 square ft. of floor space are installed 6460 horse-power in motors, 6073 in generators, and 600 horse-power in rotaries, a total of 13,133 horse-power in electrical machinery, giving a floor space of 0.63 square ft. per horse-power, or 1.24 square ft. per horse-power of generating capacity, including all regulating apparatus, switchboard, etc.

APPARATUS FOR STREET ARC LIGHTING.

At the present day, if the problem of arc lighting for street purposes with 25-cycle three-phase current supplied, were to be placed before an engineer, several methods of solution would suggest themselves in the following order: First, rectifiers; second, motor generator sets, converting to 60 cycles constant potential, with some form of transformer or reactive coil to regulate for constant current; third, motor-generator set converting to constant continuous current; fourth, motor-generator set converting to constant-alternating current with series transformers and condensers.

The full-load efficiencies of the four systems with comparative investments and full-power factors are approximately as follows:

1	2	3	4	
Rectifiers.	Motor Generators, 60 Cycles	Motor Generators, Constant D. C.	Motor Generators, Constant A. C.	
88	83.94	78.9	86.6	% Efficiency.
53	100	94	94	% Investment.
70	100	100	100	% Power Factor.

From the above table it will be seen that the rectifier leads in all respects save one, viz., power factor (the power factors given are those of the 25-cycle end, the receiver power factor being of small importance), but in a system where the arc lighting forms a considerable portion of the system this is a serious feature, especially with generators not having good inherent regulation.

Owing to existing contracts with the city, the company was forced to adopt the third plan, but after the expiration of the present contract it will probably adopt the fourth plan, installing enclosed alternating-current lamps.

The arc-lighting equipment at present consists of 14 motor generator sets, each set consisting of one 150-kw revolving field type three-phase synchronous motor direct-coupled to two 125-light 9.6 ampere Brush arc generators, the motor being in the center, with a generator on each end, coupled by means of a very simple but effective type of insulating coupling, consisting of four arms or spiders on the motor-shaft and a similar number on the generator, compressing spring rubber rolls 3½ inches in diameter by 4¾ inches long, and placed between the two sets of arms.

These motors are started in a very simple manner. The switchboard panel controlling each motor has mounted on it one ammeter, one double-pole field switch with discharge resistance, as shown in sketch, Fig. 2, three single-pole double-throw knife switches and a rheostat. The fuse base is mounted on the back. Fastened to the wall behind each panel are the reactive coils for starting the motor.

To start the motor the three single-pole switches are thrown down, thus connecting the motor armature to the bus-bars through the re-active coils; the motor come up to full speed in about 50 seconds, taking at the start about 150 per cent full-load current. The time of attaining synchronism is determined by touching the blades of the field switch connected to the revolving fields on the discharge resistance clips and noting if any spark occurs. In the absence of any, the field switch is closed, exciting the fields and the single-pole double-throw switches turned up one at a time (the motor running single-phase meanwhile).

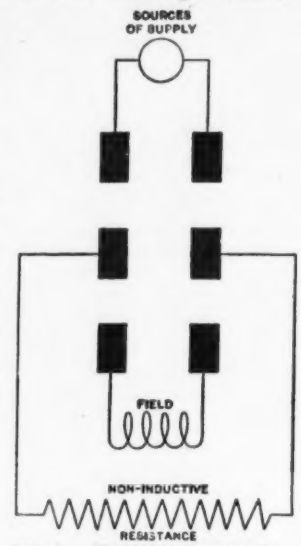


FIG. 2.—CIRCUITS OF SWITCH.

The spark at the discharge resistance terminals is, of course, due to the speed of the motor. At the start this gives about 2200 volts, dying down in inverse ratio to the speed attained, to zero, at synchronism.

The 550-volt power service is supplied from rotary converters in the usual way, calling for no comment beyond the method of starting form the A. C. end, which is done in exactly the same way as in the synchronous motors; the fields being stationary, a multiple blade switch is mounted on the frame of the machine to isolate each field winding, and thus break up the induced electromotive force at starting.

60-CYCLE SYSTEM.

Three 500-kw three-phase synchronous revolving field type motors direct connected to 500-kw revolving field 2200-volt quarter-phase generators, furnish the current for this system. The feeders are connected to double-throw oil switches, so that they can be thrown from one phase to the other to balance up the load, a further control of the voltage being obtained by means of regulators on each phase. Some rather unusual problems presented themselves in synchronizing these 60-cycle generators. The motors having eight poles and the generators 20, it is evident, that only every fifth pole of the motor will be the proper point to look at. At first it was supposed that by opening the field switch on the motor that it would slip a pole when the generator field was excited, and the whole iron losses acting as load, but the voltmeter showing the resultant voltage between the bus-bars and the ingoing generator refused to move. The synchronous motor was too good a hysteresis and reaction motor, but the solution was found in putting in a reversing field switch on the motor, thus causing it to slip a pole on each reversal. Another peculiar feature was that supposing the bus-bar voltage and that of the ingoing machine to be the same, and the machines apparently in phrase, if thrown together the ingoing machine would not take more than a small fraction of the load, and no change of field strength of either motor or generator had any effect, beyond making the generator carry idle current.

We have here the peculiar combination of double synchronism, with mechanical connection besides, so that either machine may act as motor or generator according to conditions. The explanation is as follows:

The motor carrying the load sags behind a few degrees of phase, carrying with it the generator, but the later having 2.5 times the number of poles of the motor, any sag of the motor is multiplied by 2.5, thus causing a difference of phase between the loaded generator and the unloaded one great enough to render division of load impossible. Increasing the field strength of the light generator merely results, under these conditions, in the unloaded generator supplying idle cross current out of phase with the bus-bar current, and therefore not putting load on its own motor. Manipulation of the motor field rheostats can evidently accomplish nothing to bring the generators into phase.

The solution is a rather startling one, and is found in the use of oscillatory currents. The in-going generator is excited to such a degree that the resultant voltage from it and the bus-bars is equal to the latter; this means at half load on one, and the other light, an increase of 4 per cent in voltage, indicating a phase angle difference of about 22.5 in the generators and 9 degs. sag in the motor. The motor fields are weakened and the unloaded generator thrown on the bus-bars. Owing to the difference of voltage and phase the sudden closing of the circuit establishes strong oscillatory currents between the generators; these are transmitted mechanically to the motors and repeated, the amplitude gradually decreasing from a maximum value of 100 per cent full-load current to zero as the equilibrium of the circuit is established. The whole time, from the moment of putting the unloaded generator into multiple to the disappearance of the oscillations, is usually about 45 seconds, during which the field strengths of the generators and motors are rapidly equalized, and the load will be found to be perfectly divided between the two generators, the mechanical oscillations having resulted in the only stable equilibrium possible under the conditions.

EXCITERS.

Before the installing of the storage battery it was necessary to have some quick means of getting continuous current, to determine the polarity of the rotary converters and energize the fields of the synchronous motors in case of a shut-down on the power circuits, and for this purpose two exciter sets consisting of 30-hp induction motors direct connected to 20-kw, 125-volt continuous-current generators were installed. Since the installation of the battery, all the exciting current is taken from it during the period of heavy load, for two reasons—first, to reduce the peak load; second, to automatically maintain an almost constant power factor of 98 per cent leading, on the total load of the plant, due to the Edison load increasing (and bus-bar pressure increasing correspondingly) simultaneously with the other station load and thus giving increased c. e. m. f. in the motors.

EDISON SYSTEM.

There are evidently two ways of converting three-phase, 25-cycle current into 120 to 150-volt continuous current, one being by means of tranformers with rotary converters and the other with motor generator sets.

A comparison of the net efficiency of both systems for 200-kw units is given in the following table, the rotary including in its circuit some form of regulators capable of varying the voltage 25 per cent.

	Motor Generator.	Transformers and Rotaries.	Difference.
Full load	87.40	89.87	2.47
Three-quarter load	85.54	88.70	3.16
Half load	81.42	84.90	3.48

Owing to the additional regulating apparatus necessary with the rotaries, the first cost in either case is practically the same.

From the above efficiencies, rotaries would seem to be indicated as the best choice, but in an extensive power transmission scheme, where nearly 50 per cent of the load is used for railway purposes, and the generators have a comparatively poor inherent regulation to enable them to withstand safely severe short circuits on the lines, rotaries have had to be abandoned for this service, every fluctuation of the line potential being reproduced on the direct-current side. Two 100-kw rotaries were installed, but additions have been made to the system only in motor generator sets, two of which are installed, the first of which is a direct-connected set, consisting of a 425-kw motor coupled to two 200-kw generators, having a very wide range of voltage to permit of changing the battery direct without the intermediary of a booster; the second, now being installed, is an 850-kw motor direct coupled to two 400-kw generators.

A 150-kw booster set consisting of a synchronous motor coupled to two direct-current boosters is used for charging purposes, and for carrying long feeders. The storage battery has a capacity for one and a half hours of 6000 amperes at 150 volts, there being 75 cells on each side of the system with two 20-point end-all switches, on each side to give control of the pressure under varying load.

A peculiar point observed is that a motor generator set and rotaries operating in multiple on the direct-current side, tend to regulate one another, with varying speed, for constant potential. The rotary being practically independent of speed, a fall of speed or frequency on a transmission system having a large amount of inductance reduces the reactance, and a rise in speed increases the latter so that but for changes in the impressed voltage the rotary should give the best results on a system driven from water power in which the governors must of necessity be sluggish. The motor generator, on the other hand, is independent of changes in impressed voltage, but sensitive, especially with under-saturated fields, to change of speed.

New York Meeting of the American Street Railway Association.

Plans for an unusually large and important street railway convention in this city are being actively pushed and developed. The twentieth annual meeting of the American Street Railway Association will be held in Madison Square Garden, New York City, Wednesday, Thursday and Friday, Oct. 9, 10 and 11, 1901. Papers will be presented on the following subjects: "Street Railways: A review of the Past and a Forecast of the Future"; "The Adoption of Electric Signals on Suburban and Interurban Railways, Single or Double Track, and Their Economy of Operation"; "The Value of Storage Batteries as Auxiliaries to Power Plants"; "The Public, the Operator and the Company"; "The Best Manner and Mode of Conducting the Return Circuit to the Power-house"; "The American Street Railway Association: The Purposes of its Organization and the Benefits Accruing to Investors in and Operators of Street Railway Properties by Membership Therein"; "The Economies Resulting from the Use of Four Motors Instead of Two on Double-motor Equipments"; "The Best Form of Car for City Service: A Consideration of the Various Types of Car as to Size of Car and Arrangement of Seats, Including Best Types of Brakes and Wheels"; "Practical Results Obtained from Three-Phase Transmission and Rotary Transformers or Motor Generators in Transmitting Power on Railway Lines"; "Relations of Interurban and City Railways"; "The Modern Power House, Including the Use of Cooling Towers for Condensing Purposes."

Friday, Oct. 11, has been set apart as a day for the examination of the exhibits. No session of the association will be held then, so that all may have time to view the exhibits. The annual banquet will be held Friday evening, when the officers-elect will be installed. The headquarters of the association will be at the Murray Hill Hotel. Regular rates will prevail, viz., $2 to $5 per day, European plan; $4 to $7 per day, American plan. No rooms will be assigned prior to April 15. The assignment will be made under the supervision of the local committee, preference to be given to members of the association.

National Electrical Trades Association.

Mr. R. E. Gallaher, who has just returned from Chicago, reports that a very harmonious and successful annual meeting of the National Electrical Trades Association was held there, accompanied by various festivities, including a dinner given at the Union League Club by the Chicago Association, and an evening at the theater. Officers were duly elected for the ensuing year, Messrs. W. M. Carpenter, of the Western Electric Company, as president, and Charles Price, of Pettingell & Andrews, as vice-president, with the old board of directors, Messrs. Gallaher, C. M. Wilkins, Price, W. M. Carpenter, chairman, and F. D. Lawrence. Mr. F. P. Vose was re-elected secretary and treasurer. The next meeting will be held in Philadelphia in March, 1902. The reports presented at this meeting were most encouraging as to the good accomplished by the association in behalf of its members. Not the least pleasant feature of the occasion was the hearty and liberal entertainment provided by the Chicago members.

Perils of Line Construction in Alaska.

The story of telegraph submarine cable and land line construction in Alaska promises to be an exciting and eventful one before the work is finished. The first details have just come to hand of the hardship and suffering endured by two corps of soldiers and engineers who attempted to construct a telegraph line between Dawson City and Fort St. Michael. A miscalculation was made and the two corps, working from opposite ends of the line, missed each other by 70 miles. It appears that it was necessary to send a relay expedition drawn by reindeer, to rescue the soldiers from death. A letter from Mr. Willard, dated at Eaton Reindeer Station, Dec. 31, 1900, says: "Lieutenant Offley left Unalalik as winter was setting in to build a line to Kaltag. At the same time Lieutenants Smith and Grimm set out from Kaltag to build across the portage, and the detachments were to meet half way between Kaltag and the coast. In the middle of the winter word was brought by travelers that Lieutenants Smith and Grimm, after building 18 miles of telegraph line, were in distress. They had several men with them, and, as there were no supplies at Kaltag and they had no communication with any other place, they were in danger of starvation. Their mule team had gone through the ice of a river and the load of provisions was lost.

"All the men were turned out to shovel snow in an effort to move forward. This proved useless, for the mules at every step left a track of blood. Their hoofs were torn and their legs were cut at every step. As soon as he heard of their condition, Lieutenant Offley took a dog team and started to find them. He found them in a frightful condition. They had leather shoes, which are of no use in this country, and their feet, hands, ears and faces were frozen. They were living on half rations.

"Their mules were suffering so much that two of them were shot. A request was sent to Dr. Francis H. Cambell, superintendent of the Government reindeer in Alaska, that some of the deer from the Eaton station be sent to rescue the party. Thirty reindeer hauling sleds, were sent to the rescue. They proved to be superior to dogs, as it costs nothing to fed them. By Dec. 20 the soldiers had reached Unalalik."

The Quotation War in Chicago.

Official announcement was made in Chicago on March 23 that the controversy between the Chicago Board of Trade and the telegraph companies over the collection and dissemination of market quotations had been settled. The agreement was made at a meeting, at which were present President Warren, of the Board of Trade; Colonel Clowry, of the Western Union Telegraph Company, attorneys for all the parties interested, and several members of the Board of Trade Quotation Committee. The trouble started last July, and since that time the country has not had Chicago grain quotations, except as they were sent out over private wires from brokers, or in private messages, or in newspapers after the market closed. In making the announcement President Warren said: "The board and the telegraph companies have settled their differences in a way satisfactory to the board. I don't care to give out the details of the agreement until the formality of signing the contracts has been observed. The telegraph companies will be free to send out the quotations April 1." It is understood the agreement calls for the payment of an aggregate sum of $30,000 per annum by the telegraph companies to the board, the maintenance of rates in the local field so as not to crush out the Cleveland Telegraph Company, which has been handling the quotations in Chicago under the direction of the board, and which has a 20-year contract with the board, and the control by the board over applications for quotation service. The Board of Trade is to indemnify the telegraph companies against possible expense or damages obtained from the telegraph companies by reason of the disapproval of applications by the board.

To Study American Electric Railways.

A London dispatch dated March 9 conveys the intelligence that the Midland Railway Company is sending two engineers, Messrs. Seeley and Woollinscroft, to the United States to study American railway methods, including the adaptation of electricity to railways.

CURRENT NEWS AND NOTES.

LONDON'S FIRE-ALARM SYSTEM includes 84 watch boxes, 675 fire alarm points, 7 bell-ringing fire alarm stations, 111 telephone lines between fire stations, 31 telephone lines between police stations and 110 telephone lines to police and other buildings.

MUNICIPAL ELECTRICIANS.—We have received from Mr. Morris W. Mead, of Pittsburg, Pa., president of the International Association of Municipal Electricians, a copy of the official report of the fifth annual convention of that association, which was held in Pittsburg last September. The book contains 202 pages and is substantially bound in maroon leather. It contains a historical sketch of the organization, portraits of the officers, past and present, and the papers read at the meeting and discussions thereon. Its contents will be valuable to the members and electricians in general. The latter will learn much about municipal electrical work and the problems which confront municipal electricians.

STREET CAR HEATERS IN GERMANY.—Under date of Feb. 11, 1901, Consul Warner, of Leipzig, reports that there is great need for electric heaters in the street cars of that city, the three electric street railways in and about Leipzig not having a single car which is heated either by electricity or coal on the coldest days in winter. Formerly, when horse cars were in use, they were heatd by placing coals of fire in iron boxes; but, after several months' trial, the system was abandoned. Mr. Warner urges the introduction of American electric street car heaters, but adds that, in order to meet with success, it will be necessary, first of all, to convince the authorities of the fact that the health of the general public is greatly endangered by riding in unheated cars during the winter months.

SOUTHWESTERN GAS, ELECTRIC AND STREET RAILWAY ASSOCIATION.—The third annual meeting of this association will be held at Houston, Tex., on April 19-22. The following is a list of the papers to be read at the meeting: "Municipal Ownership vs. Private Corporations," T. D. Miller; "Association Between Meetings," C. A. Newning; "Station Work," Geo. Cushman; "Corporations and Its Employees," H. F. MacGregor; "Street Railways of Texas," F. E. Scovill; "Inspection," W. S. Rathell; "Electrical Potpouri," John G. Boyd; "What Are We Here For?" E. L. Wells; "Cheap Fuel and How to Use It Economically," L. T. Fuller; "Water Power for Small Plants," F. R. Starr. The railroads have granted one and one-third rates for the round trip. T. H. Stuart, of Waco, Tex., is the secretary of the association.

BUCKET SHOP TAXATION.—The Commissioner of Internal Revenue, in a decision published last week, states that it is the clear intent of the act of March 2, 1901, known as the Revenue Reduction act, that every person engaging in the business described in the third sub-division of Section 8 of that act (bucket shop brokers) shall pay special tax as regular brokers, and in addition shall pay a special tax as bucket shop brokers. The instructions of the Commissioner of Internal Revenue to collectors require the blank form of notice of intention to commence or continue the bucket shop business to be placed in the hands of these taxpayers at the earliest possible date, as this tax of $12.50 for the three months ending June 30, 1901, is payable April 1, in addition to the special tax as brokers, and after July 1, 1901, they must pay this tax, as well as that of broker, the two taxes aggregating $100 per annum. A keeper of a bucket shop who is caught doing business without filing a notice of intention and paying the tax is liable, in addition to the tax, to a fine of not less than $500, nor more than $5,000, or imprisonment for not less than three months nor more than two years, or both, at the discretion of the Court. The law also expressly declares that the payment of the tax and compliance with the law shall not be held to authorize the commencement or continuance of a bucket shop business contrary to the laws of any State.

SUBSTITUTE FOR RUBBER.—The State Department is in receipt of the following report from Consul Nelson, of Bergen, dated Feb. 6, 1901, relative to the discovery of a cheap substitute for rubber: "After having experimented for several years, a Copenhagen chemist has succeeded in producing a material called "solicum," which possesses qualities that will render it of the greatest importance to the caoutchouc industry. It is produced, it seems, from

asphalt, and can be used for the manufacture of linoleum, rubbers, insulators, etc. It is also claimed that the material can be used as a paint, in all colors, and that it is absolutely waterproof.

BUCKET SHOPS.—The Court of Appeals, in Illinois, has sustained the decision of the lower court that bucket shops are not entitled to exchange quotations.

RUSSIAN PIONEERS IN ELECTRICITY.—The Imperial Technical Society, of Russia, has issued a pamphlet giving an account of the pioneer work of Russians in the branch of electricity and its applications during the century ending with 1900. The pamphlet was originally issued as an explanatory catalogue of the exhibits of the Society at the Paris Exposition. The pamphlet includes a large number of illustrations of the pioneer apparatus, and a number of portraits, including those of Baron Shilling De Kannstedt, Jacobi, Lenz, Jablochkoff, Lodyguine and Dolivo-Dobrowolsky. The well-illustrated notices of the early Russian work in electricity gives a considerable historical value to this pamphlet.

POLITICS ON THE PACIFIC COAST.—The last Congress was quite liberal in providing for electrical improvements on the Pacific Coast. An appropriation was secured for making a beginning of a cable from Alaska to Puget Sound, and the War Department has authorized the laying of the section extending from Skagway to Juneau. For a cable extending from the mainland of the State of Washington to Tatoosh Island, at the entrance of the Straits of Fuca, $20,000 was appropriated. The appropriations made at the last two sessions of Congress for electrical and other improvements at the naval station at Bremerton, Puget Sound, aggregate over $600,000.

TECHNICAL ABSTRACTS.—Nos. 6 and 7 of the second volume of our esteemed contemporary, *Le Mois Scientifique et Industriel,* contains more than 200 pages and two or three times that number of abstracts of important articles selected from the periodical technical literature of the world. A new feature appears in this number consisting of a list of all the French patents issued during the months of October and November, accompanied by a concise statement of the subject of each patent. The value of many of the digests, particularly in the engineering department, is much enhanced by the inclusion of illustrations. The value of this very useful publication increased progressively, and we commend it to such of our readers as are conversant with the French language.

GASOLENE FOR INTERIOR ILLUMINATION.—The inspectors of oils for the first and second districts of Ohio have issued a circular calling attention to certain statutes relating to the use of gasolene, and which concludes as follows: "Gasolene is not intended for illuminating purposes and will not meet the required legal test; and any person who sells or offers gasolene for sale for such purpose, or any person who uses gasolene in lamps or other devices for illuminating purposes, except as stored in underground reservoirs outside the building to be lighted, violates the law, and is liable to the penalty prescribed for such violation; and persons are hereby notified that any violation of the foregoing sections of the revised statutes will be prosecuted by the officers of this department."

ELECTRIC POWER IN THE GOVERNMENT PRINTING OFFICE.—In a discussion at a recent meeting of the Franklin Institute, on the subject of electrical distribution of power in workshops, Mr. W. H. Tapley stated that the Government Printing Office at Washington has now a motor equipment of 854 horse-power distributed among 200 motors. Of these 145 motors are geared to presses, aggregating a horse-power of 375. For lighting there are the equivalent of 5000 16-cp lamps and an average of 70 amperes of current is used in heating 10 press heads. Although the power used in 1899 was more than double that used in 1894, and the boilers were called upon to heat 1,000,000 cubic ft. more of space, the total cost of coal and gas for 1899 was only $5,614.75, as against $27,812.13 in 1894.

ENGINEERING LECTURES AT THE UNIVERSITY OF ILLINOIS.—The following course of lectures, under the auspices of the Mechanical and Electrical Engineering Society of the University of Illinois, will be delivered by non-resident engineers during the current spring semester: Mr. J. V. Schaefer, of the Link Belt Manufacturing Company, Chicago, Ills., on "The Handling of Materials by Means of Endless Elevators and Conveyors." Mr. John Birkinbine, consulting and expert mining engineer, Philadelphia, Pa., on "From Mine to Furnace." Mr. William Kent, associate editor *Engineering News,* New York City, on "Steam Boiler Efficiency." Mr. W. L. Abbott, chief operating engineer, Chicago Edison Company, Chicago, Ills., on "Recent Development in Central Station Electrical Supplies." Mr. W. A. Layman, electrical engineer, Wagner Electric Manufacturing Company, St. Louis, Mo., on "Some Important Considerations of the Design, Manufacture and Use of Transformers." Mr. T. P. Gaylord, electrical engineer, Westinghouse Electric Manufacturing Company, Chicago, Ills., on "Alternating-Current Power Works." Mr. Bion J. Arnold, consulting engineering, Chicago, Ills., on "Central Power Station Design." Professor L. P. Breckenridge, Ph.B., Professor Mechanical Engineering University of Illinois, on "Locomotives at the Paris Exposition."

SUMMER SCHOOL OF APPRENTICES AND ARTISANS.—The University of Wisconsin will conduct a summer school for apprentices and artisans, the session beginning July 1 and ending Aug. 9. The school is for the benefit of machinists, carpenters or sheet-metal workers; stationary, marine or locomotive engineers; shop foremen and superintendents; superintendents of water works, electric light plants, power stations, factories, large office and store buildings in cities; and for the young men who wish to qualify themselves for such positions. For these employments the full four-years' professional courses in engineering are not required, and yet to satisfy the present demands upon this class of men it is necessary for them to obtain considerable theoretical and practical knowledge not commonly taught in any of our schools. One of the leading purposes of the school is to supplement the work of the Correspondence Schools. Persons coming with a fair knowledge of the theory of a certain line of practice can spend their entire time in the shops or laboratories if they choose, and so put into practice, or prove experimentally, the scientific principles learned from books, or in the correspondence courses. There are no correspondence courses given in this University, but persons applying to the University for correspondence instruction will be referred to the regular correspondence schools, some of which are giving very good and thoroughly sound instruction along many lines of engineering and mechanical practice. If the interest shown in the school and its purposes should be considered sufficient to justify the institution of a regular artisans' course extending throughout the year, the University will endeavor to establish the same.

TROLLEY CAR BARNS.—It is stated that the interest of companies in the approaching rating of the risks under the United Railway & Electric Company's schedule in Baltimore has been increased by the loss reported under the International Traction Company's schedule, Buffalo, concerning which so much discussion as to the proper rating recently arose. In commenting on the general subject of rates on electric railway property, the New England special agent of a prominent company says: "It is the opinion of an electrical expert that the recent loss at Providence, R. I., on the Elmwood car barns of the Union Railroad Company was caused by an overheated 'heater,' or by defective insulation of the wire by which current was supplied to the same. I find it is the custom of many street railways, especially those using large pattern cars, some 40 ft. in length, to leave the trolley on the wire after the car is run into the car house, so that the whole current is continuously supplied to the heaters. It is fair to assume that the continuous radiation of heat so generated would in time carbonize to a dangerous extent the wood near the heaters. I have it as the opinion of the superintendent of one of the roads in New England that passengers often endanger the insulation of the supply wire by hitting the heater with their feet, and, in consequence, the danger of short circuiting is great. Some railway companies now protect their heaters by a wood slat frame placed over same. I believe that companies and rating committees should give special consideration to the great hazard pertaining particularly to car barns and should compel arrangements to have the trolley removed from the wire as soon as cars are placed in the barns. If this cannot be done, or some electrical expert cannot invent a resistance device to care, after the motors are cut out, for currents of electricity in excess of that required to keep the car at normal heat while standing in the barn, companies should insist on higher rates."

THE EADS BRIDGE TUNNEL in St. Louis will, a St. Louis correspondent informs us, be freed from gases and other objectionable conditions by the substitution of electric or compressed-air motors for steam, or eleminated altogether as a factor in the passenger traffic, in time for the World's Fair.

TO CONNECT ODESSA AND BERLIN BY TELEGRAPH.—United States Consul-General Guenther, of Frankfort, has notified the Department of State that the Russian Government, in order to facilitate the telegraphic business between Odessa and Berlin, will construct a long direct line across Russia between these two cities.

ELECTRIC RAILWAYS IN HAVANA.—Mr. Edwin Hanson, president of the Havana Electric Railway, has just returned to Montreal from Havana. He reports satisfactory progress in the work of constructing the railway. The system, which is being built by Canadian and American capital, will comprise some 40 miles of track. About one-half of it will be in operation about the end of March. Half of the line will be double track, and the double overhead trolley system will be used. The company is contemplating the extension of the railway to other parts of the city and its environments.

A PLUG CUT-OUT AMMETER.—An interesting form of ammeter is the subject of a patent issued March 19 to Gustave Grabosch, of Berlin, Germany. The ammeter is adapted for introduction into an Edison plug cut-out socket, and externally resembles an Edison plug cut-out very closely. The instrument consists essentially of a hollow spool, the lower part of which is provided with a metal-sheathed screw thread, and the upper part with a winding which is connected in circuit when the socket is screwed home. The cylindrical bore of the spool contains a spindle carrying a metal strip and provided with a pointer and a spiral spring. In order to protect the pointer and internal parts of the device, the top has a cap of transparent material, such as mica or glass. If the apparatus is plugged in the circuit the latter is closed, the current passes through the coil and acts on the metal strip mounted on the spindle and carries the pointer along a scale, the amount of deflection being the measure of the current strength.

ACTIVE MATERIAL FOR ACCUMULATOR PLATES.—It is well known that the oxides of zinc and magnesium form with the chlorides of these metals, basic insoluble compounds. This is also the case with cadmium oxides, and a patent issued March 19 to E. W. Jungner, of Stockholm, Sweden, deals with this property of cadium oxide, and its use to form active material for storage battery plates. A suitable grid indifferent to the electrolyte to be used, such as copper, is coated with cadium oxide that has been stirred up with water containing a small quantity of ammonium chloride. As soon as dry the electrode is placed in a solution of ammonium chloride for from two to fifty hours, whereby a solid mass is formed. The electrodes are then placed in an alkali bath to reduce the metal to a metallic state by removing the oxygen and chlorine from the basic salt. In this manner the cadium is deposited on the grid in a chemically divided state that partly retains the solidity of the basic solid mass. The electrode is then ready for use in a storage battery in connection with a silver oxide element.

AMERICAN INSTITUTE ELECTRICAL ENGINEERS.—At the last meeting of the Council of the Institute the board acting upon the preliminary balloting as to officers for the ensuing year selected the following ticket: President, Charles P. Steinmetz; vice-presidents, Samuel Sheldon, George F. Sever, M. I. Pupin; managers, J. W. Lieb, Jr., Samuel Reber, Charles F. Scott, W. E. Goldsborough; treasurer, George A. Hamilton; secretary, Ralph W. Pope. In the nominations for president Mr. L. B. Stillwell and Dr. M. I. Pupin occupied respectively second and third places. Mr. Steinmetz received 76 votes from members, Mr. L. B. Stillwell 65 and Dr. Pupin 44. The salary of the secretary was raised from $2,500 to $3,000. The committee of the Institute having in charge the plans for the conversazione at Columbia University on April 12, has issued a circular letter of information to intending exhibitors, copies of which can be obtained from Secretary Pope. The current available at the University is 115, 220, 440 and 500 volts direct; 115 volts two-phase, 60-cycle alternating, and 115 volts single-phase, 130-cycle alternating. Requests for space should be filed this week.

AUTOMATIC ELECTROLYTIC LAMP.—A patent issued March 19 to Professor R. A. Fessenden describes an automatic method of cutting off the current through the heater of an electrolytic lamp as soon as the glower becomes conductive, the arrangement also serving as an automatic regulator for the glower current. A small transformer has its primary connected to the line, and is supplied with two secondaries, one of which is in series with the heater and the other in series with the glower. The heater secondary has a relatively large effective impedance while the glower secondary has a relatively small effective impedance. When the switch of the primary is closed, a small voltage will be produced in the heater secondary, say, 5 volts. At the same time a large voltage will be produced in the glower secondary coil, say, 500 volts, and which may be, say, 10 times greater than that required to normally operate the glower; as a consequence, the current will be established through the glower much sooner than if the latter were merely subjected to the working voltage. As soon as the current begins to flow through the glower it will exert a demagnetizing effect on the core of the transformer, and the magnetic flux will gradually drop until a normal current is flowing through the glower, the voltage then at the extremities of the pencil being, say, 50. The flux being thus reduced in the transformer, the voltage on the heater secondary will be reduced to but one-tenth, and consequently the current in the same will be reduced in the same proportion and only about one per cent approximately of the total energy will be consumed therein. This small waste, which may be made as small as desired by proper proportioning, can be neglected. The reduction of the magnetic lines in the core, as above stated, will also react on the primary coil, and as a consequence the lamp is to a very considerable degree self-regulating, any excessive current in the glower automatically reducing the magnetic flux and consequently the current through the glower. Means are provided for automatically short circuiting the glower circuit in case of breakage of the glower, thus preventing a high voltage being impressed on the heater circuit.

LETTER TO THE EDITORS.

The Invention of the Telephone.

To the Editors of Electrical World and Engineer:

Sirs:—In reply to your suggestion, I submit the following comments on Mr. Skinkle's claim to the invention of the speaking telephone. I speak of the matter with reluctance, because I do not care to revive controversies long since settled, but feel constrained to state my understanding of the facts.

Mr. Skinkle was employed by my firm in 1875, as he states, as a draughtsman. He knew nothing whatever of electricity when he came to us. In 1875 and 1876, as well as later, he made numerous drawings of Gray's inventions, and became thoroughly familiar with them. Gray spent practically most of his time in January and February, 1876, in our office in Washington, preparing numerous applications. The idea of the possibility of the invention of a speaking telephone was then in the air, so to speak, and was freely discussed in the office. My impression is that Mr. Skinkle derived everything he knew on the subject from conversations with Gray and others in our office at that time. I remember experimenting with the "lover's telegraph" at that time (in January, 1876) with Professor Henry in my office, where Gray explained his inventions to him.

The applications of Gray's patent, No. 173,460, of Feb. 15, 1876, for "Automatic Circuit Breakers for Electro-Harmonic Telegraphs," was filed Jan. 8, 1876, and prepared, of course, some time prior to that date. The drawings of that patent, made by Mr. Skinkle, will show whence he derived his knowledge of the mechanism shown in his sketches. The combination of the diaphragm and magnet was also old and well-known at that time, and shown in some of Gray's earlier patents or applications. My impression is that the drawing shown me by Mr. Skinkle consisted of two of Gray's organ-pipe transmitters in circuit. I have no recollection of the description accompanying his drawings.

In addition to other suggestions made by me, I called Mr. Skinkle's

attention to the impropriety of a confidential employee attempting to avail himself to the detriment of a client of information incident to his employment. Whatever question of originality there may be between Skinkle and Gray is unimportant, to my mind, in view of the fact that the application of Bell's telephone patent of March 7, 1876, was prepared at least as early as December, 1875, and the crude drawings and descriptions of untried devices could have no standing, in view of Bell's prior invention and prompt reduction to practice.

I fought earnestly for Gray's rights, and only desisted when convinced that he was not legally or morally entitled to the invention of the telephone. Mr. Skinkle was fully aware of Bell's invention and claims, but never, to my knowledge, claimed to be prior in date to him, whatever may have been his contentions in regard to Gray; and, of course, as to the latter, he was estopped by his acquiescence in Gray's claims. He made and witnessed the drawings of Gray's caveat filed Feb. 14, 1876. The subject is capable of indefinite expansion, but I refrain from further comment.

WASHINGTON, D. C. W. D. BALDWIN.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Modified Induction Motor.—GROB.—An article giving the theory of a three-phase induction motor, in which stator and rotor are connected in series. The two rotary fields must have the same speed in space; for that reason the rotor must have double the speed of the stator field and the rotor field must rotate in the opposite direction. He gives briefly the theory of such a machine and shows that it exerts a torque. It is a synchronous motor and not self-starting. He compares the properties of the same motor, in the one case connected as an ordinary induction motor, in the second case as a synchronous motor, and assumes that the utilization of the copper and iron are the same in both cases. This condition requires the double voltage for the synchronous motor; the speed is doubled for the synchronous motor, the no-load current is reduced to one-half, the maximum torque is doubled, the angle of phase is reduced to one-half; the efficiency is nearly the same. He also gives a comparison of both motors at equal speed. The voltage and the no-load current are the same; the overload capacity is about doubled with the new connections; the power factor has slightly increased; the efficiency is about the same. Rotor and stator may also be connected in parallel, but the two circuits must then be well balanced. A set of two such motors, coupled together, can be run at four different speeds; both motors in parallel, each with stator and motor in parallel; both motors in parallel, each used as ordinary induction motor; the rotor of the one motor, used as ordinary induction motor, supplies the current to the second motor, in which stator and rotor are in parallel; both motors run as ordinary induction motors, the secondary of one supplying current to the primary of the other. The four speeds have the proportion $2 : 1 : \frac{2}{3} : \frac{1}{2}$. He remarks that the same method can also be used for two-phase motors, but not for single-phase motors. He has not yet confirmed all of his theory experimentally, but a first experiment shows that a motor, connected by his method, runs and gives the maximum torque according to the theory.—*Elek. Zeit.*, March 7.

REFERENCES.

Rotary Magnetic Field.—A didactic article, with diagrams, showing the relation of the magnetic fluxes in a rotary magnetic field and methods of calculating the fluxes by means of vectors.—*Am. Elec.*, March.

Repair Shop Notes.—WEEKS.—An illustrated article on the tearing apart, repairing and replacing of a commutator, with some practical suggestions.—*Am. Elec.*, March

Surface-Wound and Slot-Wound Armatures.—HELDT.—A comparison of surface-wound and slot-wound armatures in which the author shows that slot-wound machines are cheaper and more efficient than surface-wound machines.—*Am. Elec.*, March.

LIGHTS AND LIGHTING.

Blue Island.—An illustrated description of the alternating current lighting plant of Blue Island, Ill. Series arc lamps and series incandescent lamps of 50 candle power for street lighting, and ordinary multiple incandescent lamps of 16 and 8 candle-power for store and residence lighting, are operated from one machine, a 120-kw, 1100-volt inductor alternator. For street lighting the 1100-volt current is carried to two 15-kw step-up transformers, which raise the voltage to 2000; the 2000-volt current is sent through two 25-light regulators, and on each circuit 17 arcs and 40 incandescent lamps of 50 candle-power are operated. The commercial incandescent lighting is operated at 1100 volts primary, and by the use of transformers the current is stepped down to the secondary voltage of 110 volts, the transformers being placed at the points of distribution.—*West. Elec.*, March 16.

REFERENCES.

Consumption of Carbons in Arc Lamps.—An anonymous illustrated account of experiments made to compare the carbon consumption of high voltage and low voltage arc lamps.—*Elek. Anz.*, Feb. 10, 17.

Light Prints.—An illustrated description of different methods of making light prints with electric arc lamps.—*Elek. Anz.*, Jan. 17.

POWER.

REFERENCES.

Drilling Machine.—An illustrated description of an electrically driven portable drilling machine. It is entirely self-contained, the motor developing 2 horse-power at 800 revolutions.—Lond. *Elec. Rev., Elec. Eng.*, March 8.

Recent Types of American and European Engines.—Illustrated articles describing in detail the 5000-hp compound Westinghouse Corliss engine for the Bay Ridge station of the Brooklyn Edison plant, and a triple expansion engine for electric light service, built by Bromley Bros., of Moscow, Russia.—*Am. Elec.*, March.

Driving of Centrifugal Machines.—SIMON.—An illustrated serial on the theory and practice of electric driving of centrifugal machines. —*Elek. Anz.*, Jan. 20, 24, 27.

Snoqualmie Falls.—BAKER and DOBLE.—A very long and well-illustrated article on the power transmission plant of Snoqualmie Falls.—*Jour. of Elec.*, Jan.

TRACTION.

Automobile Charging Station.—An illustrated description of the new charging station of the New York Electric Vehicle Transportation Company. There are six synchronous converters, each of 250 horse-power, which receive alternating current from the Edison mains and convert it into direct current of six voltages, differing from each other by about 3 volts. Each battery is charged first on the lowest voltage and successively on those higher, so that at no time does it get an excessive current. By using six different voltages no rheostats are required.—*The Automobile*, March.

Protection Against Shocks from Trolley Wires.—An illustrated description of the Quin patent safety device for protection against either a trolley wire breaking or against falling telephone wires. The same issue contains an illustrated abstract of an old German article by Ulbricht, in which an arrangement is described for guarding against accidents due to the falling of telephone or other wires across trolley lines; it is based on the principle of a momentary connection between the trolley wire and earth, causing a direct connection between the same, which remains until the apparatus is reset by one of the tramway officials; the efficiency of the system is largely dependent on the use of an automatic earthing device of very simple construction, which may serve to protect simultaneously several points crossed by telephone or other wires.—Lond. *Elec. Eng.*, March 8.

REFERENCES.

Car Building in England.—The first part of an illustrated description of the new car building works of Milnes & Co., in Hadley, Shropshire.—Lond. *Elec. Rev.*, March 8.

New Zealand.—An illustrated description of the trolley road of the city of Dunedin, which is the first electric tramway in New Zealand.—Lond. *Elec.*, March 8.

Interurban Line.—A brief illustrated description of the Cleveland and Eastern trolley line—*St. R'y Rev.*, March.

New England.—FAIRCHILD.—A brief illustrated description of the street railways of Portsmouth, N. H., and Kittery, Maine.—*St. R'y Rev.*, March.

Automobiles—DE CONTADES.—An article on the electric automobiles exhibited in the Salon du Cycle.—*Cosmos*, March 9.

An Unusual Condition.—PARHAM.—An article with diagram showing why a car ran faster with its motors in series than it did when its motors were in parallel, owing to the excessive drop in voltage on the line.—*Am. Elec.*, March.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Chicago.—A long abstract of the annual report of the Dept. of El'ty of Chicago for 1900. The average number of arc lamps for street lighting was 3867; the net cash operating cost per lamp was $58.25, the total number of lamp-hours 15,121,612, the average cost per lamp per hour 1.55 cents. Other parts of the report deal with the fire-alarm system, the police telegraph, the removal of overhead wires, etc.—*West. Elec.*, March 16.

Great Britain.—SUMMERFIELD.—An article on recent central station practice. The plant of a typical English central station of the present day is said to consist of either Lancashire or water-tube boilers, high-speed vertical enclosed compound engines, direct coupled to multipolar dynamos, which generate direct current at from 400 to 500 volts and supply a three-wire system, with storage batteries and boosters to balance and steady the load.—Lond. *Elec.*, March 8.

REFERENCES.

Russia.—PERKINS.—An article on polyphase power plants in Russia. Brief notes on the stations of St. Petersburg, Tanboy, the Port of Noworosisk, the water works plant of Moscow and the Prochoroff mill in Moscow, are given.—*El'ty*, March 20.

Lowestoft.—A long illustrated description of this new British electric lighting plant. The direct-current three-wire system is used. There are one 150-kw and one 75-kw dynamo and a battery of 270 cells, the normal discharge rate being 100 amperes for four hours.—Lond. *Elec. Eng.*, March 1.

Central Stations with Sub-Station.—EHLERT.—Continuation and conclusion of the serial on the calculation of electric central stations with sub-stations and on the choice of the best system for installations of up to 10,000 lamps and distances of up to 5000 meters.—*Elek. Anz.*, Jan. 10, 20, 31, Feb. 7.

Portland General Electric Company.—A descriptive article on some of the special features of the Portland General Electric Co., at Oregon City, Ore. Each generator is connected to two turbines, one for low heads and one for high, because of the great difference of head at various seasons. A home-made type of inductive regulator is used, which may be used to either boost or lower the voltage.—*Am. Elec.*, March.

Switchboard.—An illustrated description of a new feeder switchboard at the Newington (London) electric supply works.—Lond. *Elec.*, March 8.

British Power Bills.—MADGEN.—A paper, read before the Brit. I. E. E. on "The electrical power bills of 1900; before and after"; also the discussion that followed.—Lond. *Elec.*, March 1, 8. A long abstract of the paper in Lond. *Elec. Rev.*, March 1, 8.

WIRES, WIRING AND CONDUITS.

High-Tension Cables.—E. K. SCOTT.—An article in which he recommends the Brooks semi-solid system for high-tension cables. The cables are covered with jute braiding, and are then drawn into an oil-tight conduit into which the oil is poured at about 300 degs. F. When cold, the oil is of the consistency of india rubber solution, and should a fault occur the temporary current warms up the oil locally, making it run readily, and so automatically seals the fault. Boiled resin oil is used, and as it is heavier than water, any moisture which remains in the tube rises to the surface, the cable of course sinking to the bottom. Experience at Chatham, Rochester, Hong Kong, Glasgow, etc. has shown that this method gives practically constant insulation. The cable may be struck by lightning and yet the self-healing property is so effective that immediately afterward it is impossible to detect any fault or weakness; this has actually occurred at Chatham and New Jersey. The cables can be carried in iron pipes, but stoneware pipes, 5/8 in. thick, are also good.—Lond. *Elec. Rev.*, March 8.

Current Density in Small Conductors.—WHITCHER.—An article on "The economical current density in small conductors." He says that Kelvin's law should be taken into consideration in the design of the average house wiring system. He claims that there is no real call for nicety in regulation. He has formerly investigated the economical current density for electric light mains and found that the true economical current density is not varied by the load factor to anything like the extent usually supposed, because of the way in which the cost of the wasted energy also is influenced by the same factor; he arrived at the practical conclusion that the economical density in the mains is 600 to 700 amperes per square inch, under widely diverse conditions. He then treats mathematically the case of house wiring. He develops two formulas for the economical current density in ampere hours per square inch. For the smaller conductors in high-class wiring systems it becomes 4000 times the square root of 15 divided by the number of hours per year; for the large mains it is 20,000 times the square root of 1, divided by double the number of hours per year. If the number of hours per year is 200, these formulas give 1,095 and 1000 amperes per square inch, respectively. For 1000 hours per year the formula gives 490 and 450 amperes per square inch, respectively.—Lond. *Elec. Rev.*, March 1, 8.

Three-Phase System.—LATOUR.—A brief mathematical article "On the non-existence of the alleged superiority of three-phase currents in power transmission." He says that the usual comparison of different systems under the supposition of equal tension between the line wires is not justified. The comparison should be made under the supposition that the insulators and the thickness of the insulating material of the wires are the same in both cases; in other words, he considers the tension between any conductor and earth. He calculates an economy of 20 to 25 per cent of copper in favor of the single-phase system over the three-phase system. "As far as the economy in the installation of the line is concerned, there is no superiority of the three-phase currents, and if lighting is the only purpose of the transmission, it is a real technical mistake to use them. The expenses for the insulation of the line are thereby increased. The single-phase alternating current and still more the dirct current are the most advantageous currents from the point of view of expenses."—*L'Eclairage Elec.*, Feb. 16.

Storage Batteries for Power Transmission.—LATOUR.—A brief article on the saving of copper in transmission lines of short length with the use of storage batteries. He shows first in a general way, and then in a numerical example, the advantages of an arrangement in which a storage battery is placed at the consumers' end of a transmission line. This enables one to save considerable copper in the line, without increasing the expenses for insulation.—*L'Eclairage Elec.*, Feb. 23.

REFERENCES.

Ocean Cables.—MARSH.—A long article of a general nature on "Ocean Cable-making and laying." After some remarks on American types of cables, he describes the manufacture and the laying of trans-oceanic cables. He urges that the trans-Pacific cable could be made in the United States, and gives some statistical data on ocean telegraphy.—*Jour. of Elec.*, Jan.

Pole Lines.—KNOX.—An illustrated article on pole line construction. The dimensions are given for wooden and iron poles, and rules are given about some details of the construction.—*St. R'y Rev.*, March.

Interior Wiring.—KNOX.—An article giving wiring plans and methods of lighting a department store by electricity.—*Am. Elec.*, March.

ELECTRO-PHYSICS AND MAGNETISM.

Transparency of Bodies for X-Rays.—BENOIST.—An investigation of the relation between the absorption of X-rays by matter and its density. He defines the X-ray transparency of a body as the mass in

grammes of a prism of the body 1 square cm in base, which produces upon X-rays passing along its axis an absorption equal to that produced by a layer of paraffin 7.5 cm thick. From a large number of measurements he concludes that the specific transparency of a body is independent of its physical state. Thus water and ice of equal density would show the same X-ray transparency. It is also independent of chemical combination, the atom exerting the same absorption whatever its grouping with other atoms. A more or less strict proportionality between atomic weight and absorptivity is only observed when the X-rays are of the most penetrating kind. Otherwise the curve of absorption resembles an equilateral hyperbola. On entering the atomic weights as abscissas and transparencies as ordinates, a curve is obtained which fairly follows the hyperbola laid through lithium, but shows a maximum divergence for the atomic weights between 40 and 50.—*Comptes Rendus,* Feb. 11; abstracted in Lond. *Elec.,* March 8.

Röntgen Rays.—ROLLINS.—A continuation of his very long illustrated serial. He describes a Röntgen-light examination table, discusses the precautions which ought to be taken against diffused Röntgen light, and describes cathodes for powerful surges. The greatest problem in Röntgen-light tubes is said to be to find the best way of curing tubes suffering from terminal exhaustion. One direction in which to work is to try to find the new gases which he thinks are the cause of the "pristine" brilliancy of an X-light tube. Another possible direction appears to be to look for substances, not gases, in the metals of the terminals, which have the properties attributed to radium of giving off minute particles, the supposition being that if a cathode could be allowed with them, the great stress which can be produced in a vacuum tube might cause them to be driven against the target with sufficient force to produce "X-light."—*Elec. Rev.,* March 9.

Thermo-Luminescence Due to Radium Rays.—WIEDEMANN.—A description of an easy method of producing an intense thermo-luminescence by radium rays. The radium preparation was contained in a hole 8 mm wide, sunk into a glass plate 3 mm thick. A piece of aluminum foil was pasted over the hole, thus keeping the substance safe against moisture. The detective substance used for thermo-luminescence was the solid solution of manganese sulphate in calcium sulphate. This was spread in a thin layer on a piece of aluminum foil 6 cm square, and covered with a sheet of mica. The radium preparation was laid upon it, and left so for several hours. The aluminum foil was then placed upon a heated copper plate. At the place where the radium preparation had lain a green circle showed out, visible at some distance. That the solid solution named is only feebly incited to phosphorescence, but strongly by thermo-luminescence by radium rays, is paralleled by its behavior under the influence of discharge rays, and shows that both kinds of rays exert an influence upon the structure of the substance.—*Phys. Zeit.,* Feb. 2; abstracted in Lond. *Elec.,* March 1.

Condenser with Adjustable Capacity.—ERCOLINI.—An improvement of Brigg's adjustable condensers, made of flexible mica plates subjected to varying pressures, which gives a wide range of capacities, but is open to the objection that the variation of capacity with pressure, follows an unknown law, and is not always a certainty. The improvement consists in substituting glass plates for the flexible plates. The glass plates are mounted one above the other on metallic rails laid into an ebonite scaffolding. The scaffolding can be sheared like a parallel ruler, so that the glass plates can be made to approach each other to any extent desired. Sheets of tinfoil stuck on both surfaces serve as the metal plates. The capacity varies with the cosine of the angle of inclination of the guiding rod. The condenser can, of course, be used as an air-condenser, or immersed in a liquid.—*Nuovo Cimento,* Nov., Dec.; abstracted in Lond. *Elec.,* March 8.

Current Strength of Lightning Flashes.—POCKELS.—He has shown that the remanent magnetism produced in basalt by a magnetic field only depends upon the maximum intensity of the latter, however short the time during which that maximum intensity might prevail. This fact can be used for determining the current strength of lightning flashes by placing a rod of basalt near a lightning conductor in such a position that the circular lines of magnetic force produced by a discharge, approximately pass through the length of the rod. Some basalt rods were successfully exposed by Chistoni in the Monte Cimone Observatory in the Appennines, and the resulting magnetizations indicated currents of 10,000 to 20,000 amperes.—*Phys. Zeit.,* Feb. 16; abstracted in Lond. *Elec.,* Mar. 1.

Magnetic Expansion of Iron and Nickel.—SHAW and LAWS.—The conclusion of the article, the first part of which was noticed in the Digest March 16. The results are as follows: The curves for iron and nickel can now be plotted nearer to the origin than in any previous research, yielding evidence of a retraction of iron when the curve leaves the origin. The electric micrometer is capable of more minute work than any other form of optical lever hitherto produced. while every other measuring arrangement appears to be "out of the running." The smallest readings taken were about 0.00000005 cm. By using three specimens of one length, but of different diameters, they find that there is a general law as to the relation of diameter to slope of the curve, both for iron and nickel. This law leads to the idea of producing a curve for an ideal wire. which they call the attenuant. This curve has interest in being the lower limiting one, but it also gives a case in which the simple law for obtaining the field in a solenoid coil is accurately true.—Lond. *Elec.,* March 8.

Magnetic Induction.—BUCHANAN.—A theoretical paper, giving "A contribution to the theory of magnetic induction in iron and other metals." He shows that solutions of an equation of the same form as Fourier's partial differential equation (stating that the first differential quotient of a function, to the time, is proportional to the second differential quotient of the same function, to the length) are capable of expressing the complex results obtained in the numerous experiments which have been made on magnetic induction in iron and other metals. He discusses the following two cases: Induction by continuous increase of field intensity, and periodic variation of field-intensity and residual magnetism.—*Phil. Mag.,* March.

Magnetic Properties of Alloys.—RICHARDSON and LAWS.—A brief paper giving the results of their investigation "On some interesting changes in the magnetic condition of an alloy of nearly pure iron and aluminum (2.42 per cent) due to successive heatings and coolings." The effect of temperature on the magnetic behavior of impure alloys of iron and aluminum is very different from that on the behavior of iron itself. The curves conecting the permeability and temperature for a constant field have at least two maxima, which is explained by assuming that the specimens investigated consist of two distinct constituents. Subsequent microscopic examinations have shown the presence of crystals. In another curve three maxima were observed, which would indicate three distinct magnetic substances.—*Phil. Mag.,* March.

Magnetic Effect of Electric Charge.—CREMIEU.—An account of a continuation of his former researches which have aroused considerable interest, as they appeared to be in strict disagreement with Maxwell's theory. He has repeated his experiments on the magnetic effect of a moving electric charge, with a view to meeting the objections raised by Rowland, Himstedt and Fitzgerald. He acknowledges that the action of the armatures which are used to discover the magnetic effect looked for, is difficult to determine. He therefore devised a new experiment in which no metallic layer was interposed between the needle and the turning disk. But, as before, the revolving charge disk produced no magnetic effect whatever. It was easy, however, to obtain an effect showing the same reversibility as the magnetic effect looked for, and even agreeing with it in order of magnitude. This pseudo-magnetic effect of electric connection is due to sparks or brushes, and is in any case of electrostatic origin. It is always observed when the suspended system has not been very carefully diselectrified, or when it is not protected by a good conductor. A tube of paper covered with graphite, which constitutes a perfect electric screen for bodies at rest, ceases to be so when they are in motion. The conditions of experiments are generally so difficult that it is impossible to take a satisfactory set of readings. But he still considers himself justified in denying the existence of a magnetic effect of electric convection.—*Comptes Rendus,* Feb. 11; abstracted in Lond. *Elec.,* March 8.

ELECTRO-CHEMISTRY AND BATTERIES.

Capacity of Storage Batteries.—A long article on the characteristic curves of lead storage batteries and their dependence on the construction of the plates. He first discusses briefly the processes in a battery during discharge. If a capacity curve is plotted, the time of discharge being the abscissa, the ampere-hour capacity the ordinate, the capacity first increases rapidly with increasing duration of discharge, the capacity depending mainly upon the quantity of acid which can enter from the electrolyte into the active mass during the discharge. The greater the duration of discharge becomes, the greater is the influence of the exhaustion of the active mass, until for very small current strength the capacity is dependent only on the

quantity of active mass; the curve becomes approximately parallel to the abscissas axis. If for a given battery a set of such curves is plotted, each for a discharge down to a certain voltage (for instance, 1.8, 1.85, 1.9, 1.92, 1.95 volt), the abscissas being always the time of discharge, the ordinate the capacity, this set of curves gives out not only the capacity for any discharge, but also at once the curve of discharge itself. Any straight line through the zero point of the system of co-ordinates, represents a discharge with constant current as capacity divided by time gives the current strength. The point in which this straight line intersects any of the capacity curves, gives the time of discharge and capacity of discharge with the constant current down to the special voltage to which the capacity curve refers. The points of intersection of the straight line with the set of, say, five capacity curves, give sufficient data for plotting the curve of discharge for that special current strength, if the voltage at the beginning of the discharge is also known. He gives such curves for three batteries, differing in the construction of the plates, and discusses the influence of this construction. The curves show that for proportioning the amount of acid for portable cells it is necessary to take into consideration whether the cells are for rapid or slow discharges.—*Centralblatt f. Accum.*, Feb. 1, 15.

Law of Dissociation.—Sackur.—A summary of some recent articles of Jahn and Arrhenius. It has been a subject of some annoyance for the followers of the dissociation theory that Ostwald's law of the relations between dissociations and concentration or between electric conductivity and concentration, is not in agreement with the measurement of the conductivity of K Cl, Na Cl, H Cl for different concentrations. Jahn has endeavored to find the cause of this disagreement. He shows that it can be explained if the supposition is dropped that the migration velocity of ions are independent of the concentration. He shows that this supposition can be proven to be wrong by experiments, if Nernst's formula for the e. m. f. of concentration cells is assumed to be strictly correct. The final result of Jahn's investigation is that the conductivity measurements of K, Cl, Na Cl H. Cl can be brought into agreement with Ostwald's law, if the migration velocities are assumed to decrease with decreasing concentration; from the conductivity, therefore, the degree of dissociation cannot be strictly determined; the only strict way of determining it is Nernst's formula. Against this result Arrhenius has made the criticism that Nernst's formula is not strictly correct from a theoretical point of view; he gives a more exact formula.—*Zeit. fuer Elektrochemie,* Feb. 21.

Solubility of Metallic Deposits.—Immerwahr.—An account of an experimental investigation of the potentials of mercury, copper, lead, cadmuim and zinc electrodes in saturated solutions of their salts. From the value of the e. m. f. between eectrode and electrolyte he calculates with the aid of Nernst's formula the concentration of the metallic ions. He made experiments with chromates, phosphates, carbonates, cyanides, sulphides, also with chlorides, bromides, iodides. His results, given in tables, show distinct regularities, from which he concludes that the maximum concentration of the ions, and therefore also the solubility, is an additive property, *i. e.*, the solubility is mainly the result of a property of the two ions; this property is the "electro-affinity."—*Zeit. f. Elektrochemie,* Feb. 28.

REFERENCES.

Electro-Chemistry and Electrometallurgy.—Crocker.—The first theoretical part of what promises to become a long serial. He discusses Faraday's law at some length, gives Ohm's law and its application to electro-chemistry, discusses the specific resistance of electrolytes, the temperature coefficient of electrolytes, the conductivity of non-aqueous solutions and of fused electrolytes. He also shows how to calculate the e. m. f. of a cell from the energy changes and develops the general formula of Helmholtz.—*Sch. Mines Quart.*

Electrolytic Production of Soda and Chlorine.—Franke.—An article on the electrolytic production of pure soda and chlorine, from a solution of common salt. A spray of mercury is used as a negative electrode, and the sodium forms an amalgam with the mercury, from which it is afterward reclaimed. Chlorine is liberated at the insoluble positive electrode.—*Am. Elec.,* March.

Oxidation Cells.—Schaum.—A brief preliminary account of measurements of the e. m. f. of concentration cells with unattackable electrodes, in which he found peculiar differences between measured and calculated values.—*Zeit. f. Elektrochemie,* Feb. 28.

Old Storage Batteries—Levermann.—An article in which he discusses how to use spongy lead and old plates commercially, and what to do with them.—*Centralblatt f. Accum.,* Feb. 15.

Stationary Storage Batteries.—Schindler.—An article on the weight of stationary storage batteries and on the methods of placing them in buildings.—*Elek. Anz.,* Jan. 31, Feb. 3.

Acid for Storage Batteries.—Heinz.—An article in which he discusses the great importance of using very pure sulphuric acid for storage batteries; the degree of impurities which may be allowed is briefly discussed.—*Centralblatt f. Accum.,* Feb. 1.

Cupron Cells.—Jordis.—An article on the treatment of cells with zinc and cuprous oxide electrodes and lye of sodium or potassium as electrolyte without diaphragm. He recommends them and shows how to use them in private electro-chemical laboratories.—*Zeit. fuer Elektrochemie,* Feb. 21.

Units. Measurements and Instruments.

Electric Anemometer.—Legrand.—A description of a simple device which overcomes all the difficulties experienced in transmitting the indications of an ordinary centrifugal anemometer, to a distance. The shaft of the cup anemometer carries a small Gramme ring, which revolves between the pole-pieces of a strong permanent magnet. The e. m. f. produced in the ring is proportional to the speed of rotation. The apparatus is connected with a voltmeter formed by providing a Deprez galvanometer with a suitable damping device and a low resistance. To avoid errors due to temperature the circuit is made of manganin wire. The apparatus is graduated empirically.—*Comptes Rendus,* Feb. 11; abstracted in Lond. *Elec.,* March 8.

Electric Brake Dynamometer.—Rieter.—An illustrated description of an electric brake dynamometer of precision. It consists of a two or multipolar magnetic field system which can rotate around an axle by a few degrees and which is excited from any source of current. Around the magnetic field there is a ring of iron or steel which can be revolved. This ring forms the brake. The mechanical work, supplied by the dynamometer, is changed into electrical energy and this into heat by means of eddy currents. There is no mechanical friction.—*Elek. Zeit.,* Feb. 28.

Thermo-Elements for the Measurement of High Temperatures.—Lindeck and Rothe.—A description in detail of the methods of testing thermo-electric apparatus for the measurement of high temperatures as carried out at the German Reichsanstalt. The first part of the paper is a description of the furnaces used and the arrangement of the junctions on them. In later experiments the thermo-elements of Le Chatelier's form were compared in electrically heated furnaces, which consist of several concentric tubes, the inner tube containing the thermo-electric junction and the one next to it the wire whose rise of temperature on the passage of a current causes the heating of the furnace. These tubes are formed of a highly infusible sort of porcelain. For temperatures up to 1400 degs. the material used for the heating wire is nickel. For higher temperatures up to 1600 and 1700 degs. platinum irridium is used. In the second part of the paper full particulars are given of the method of measurement of the e. m. f. by a compensation arrangement.—*Zeit. f. Instrumentenk.,* Oct., 1900; abstracted in *Science Abstracts,* Feb.

REFERENCES.

Induction Coil and Interrupter.—An illustrated description of a new "unipolar" induction coil of Guerre and two new mercury interrupters of Guerre, to be used for Roentgen rays experiments.—*La Nature,* March 9.

Use of the Electro-Dynamometer.—Woodbury.—A note on the use of the electro-dynamometer in which the slide rule is used for computing the current.—*Am. Elec.,* March.

Telegraphy, Telephony and Signals.

Photophones.—Rubmer.—An illustrated article, in which he says that an electric arc is not absolutely essential for the transmission of speech by light. It may be accomplished by means of a simple Bunsen flame surmounted by a piece of platinum foil serving as an electrode, while the burner itself serves as the other. The flame is inserted in the secondary circuit of a transformer and a battery and microphone receiver in the primary circuit. The effect is, however, much feebler than in the case of the arc. In using the arc care must be taken to have the proper transformation ratio, the best ratio being that in which the number of turns in the two coils are in the proportion of the square roots of the resistances of the microphone and the

arc respectively; the ratio comes out as something like 1 to 2.2. To attain this ratio empirically and to vary it in accordance with the pitch of the note transmitted, he proposes to use a single coil transformer with variable contact. At the receiving station low-resistance selenium cells should be used. Under favorable conditions they may be made to work the recording magnet of a Poulsen telegraphone.—*Phys. Zeit.*, Feb. 23; abstracted in Lond. *Elec.*, March 8.

REFERENCES.

Small Telephone Exchanges.—DOBBS.—The fourth article of his serial on "The construction of small telephone exchanges." He discusses the hanging of cable spans, and the placing of the anchors and guys.—*Elec. Rev.*, March 16.

Independent Telephone Exchanges.—BURLINGAME.—An illustrated description of the branch exchange of the Cuyahoga Telephone Co. at East Cleveland, Ohio. The exchange is provided with lamp signals and a thoroughly modern equipment for 600 subscribers, with provisions for 1400 more.—*Am. Elec.*, March. (See E. W. & E., March 9.)

Intercommunicating Telephone Set.—A descriptive article with working drawings on the construction of an intercommunicating telephone set, together with plans for connecting up the instruments and wiring for four stations.—*Am. Elec.*, March.

Common Battery Telephone Switchboard Systems.—HENRY.—An illustrated article describing various methods of connecting common batteries to telephone switchboard systems.—*Am. Elec.*, March.

Statistical.—A long statistical article on telegraphy and telephony in Germany in 1899; also the conclusion of the statistical article on telegraphy and telephony in British India in 1898-99.—*Jour. Tel.*, Feb. 25.

MISCELLANEOUS.

REFERENCES.

Electric Shock Accidents.—COTTRELL.—A summary of "Precautionary instruction in relation to the avoidance of, and for the treatment of sufferers by, accidental shock from electrical current."—Lond. *Elec. Rev.*, March 8.

General Electric Co.—The first part of an illustrated description of the Schenectady works of the General Electric Co.—*Elec. Rev.*, March 16.

Paris Exposition.—An illustrated description of the induction coils exhibited.—*Elek. Anz.*, Feb. 10, 21.

New Books.

BOOKS RECEIVED.

IMPIANTI DI ILLUMINAZIONE ELETTRICA. Quinta edizione, rifatta. Di Emilio Piazzoli (Hoepli Manual). Milan: Ulrico Hoepli. 605 pages, 263 pages. Price, 6.50 lire.

AMERICAN ENGINEERING COMPETITION. Being a series of articles resulting from an investigation made by the *Times*, London. New York: Harper & Brothers. 139 pages. Price, $1.

RECENTI PROGRESSI NELLE APPLICAZIONI DELL ELETTRICITA. Di Rinaldo Ferrini. 3a edizione, completemente rifatta. Milan: Ulrico Roepli. 283 pages, 109 illustrations. Price, 7.50 lire.

ELECTRIC LIGHTING. A Practical Exposition of the Art for the Use of Engineers, Students and Others Interested in the Installations or Operation of Electrical Plants. By Francis B. Crocker, E. M., Ph.D. Volume II. New York: D. Van Nostrand Company. 505 pages, 391 illustrations. Price, $3.

Directory of Electrical Societies, Etc.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, New York, Oct. 9, 10 and 11, 1901.

ASSOCIATION OF THE EDISON ILLUMINATING COMPANIES. Next meeting, Sept. 10, 1901.

CANADIAN ELECTRICAL ASSOCIATION. Next meeting, Ottawa, Ont., June 19, 20 and 21, 1901.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Niagara Falls, N. Y., September, 1901.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Next meeting, Niagara Falls, N. Y., May 21-23, 1901.

NEW YORK STATE STREET RAILWAY ASSOCIATION. Next meeting, Rochester, N. Y., September, 1901.

OHIO ELECTRIC LIGHT ASSOCIATION. Next meeting, Put-in-Bay, Ohio.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. Next meeting, York, Pa., Sept. 4, 1901.

SOUTHWESTERN GAS, ELECTRIC & STREET RAILWAY ASSOCIATION. Next meeting, Houston, Tex., April 19-22, 1901.

NORTHWESTERN ELECTRICAL ASSOCIATION. Next meeting, Sheboygan, Wis., last week in June, 1901.

Automobile Notes.

At the Automobile Club of America headquarters in this city on March 26, Mr. A. L. Riker delivered an extemporaneous address on the subject of the practical handling of electric automobiles, a subject with which no one in this country has greater expert familiarity. The address was followed by a discussion. The annual dinner of the club has been fixed for Thursday, April 18, at the Waldorf-Astoria.

An automobile show began on Saturday last at the Coliseum, Chicago, under the auspices of the *Motor Age*. There are about 50 exhibitors, and the show will remain open this week. Among the exhibitors who had their displays in position last week were: Electric Vehicle Company, New York; Mobile Company of America, New York; Hewitt-Lindstrom Motor Vehicle Company, Chicago; De Dion-Bouton Motorette Company; National Automobile & Electric Company, Indianapolis; Woods Motor Vehicle Company, Chicago; Milwaukee Automobile Company; Ralph Temple Automobile Company, Chicago.

Ohio Independent Telephone Association.

Mr. H. D. Critchfield, secretary of the Independent Telephone Association of Ohio, has issued a notice of the annual meeting of the association to be held at the Chittenden Hotel, Columbus, on April 5. There are about 180 independent companies in Ohio, nearly all of which are identified with the State Association. It is announced that the business of the meeting will be to consider matters tending to promote more harmonious relations among the companies.

A New California Transmission.

The Keswick Electric Power Company is putting in a power house on Mill Seat Creek in Shasta County, Calif., for the supply of electric power to mines and towns in the copper mine district. Redding and Keswick will be supplied with light and the De Lamar and other copper mines furnished with light and power. The water power is to be taken in a ditch 6000 ft. long to a point where a fall of 1171 ft. to the power house will be obtained. The pipe line is to be 30-inch steel pipe. The machinery contracted for consists of two Pelton waterwheels, to run 400 r. p. m. direct connected to two 750-kw Westinghouse generators. The transmission system will be at 20,000 volts, three-phase, the longest transmission being 45 miles. There will be two circuits on one pole line. H. H. Noble, of San Francisco, is president of the company, and Hunt, Meredith & Corey, of San Francisco, are the consulting engineers.

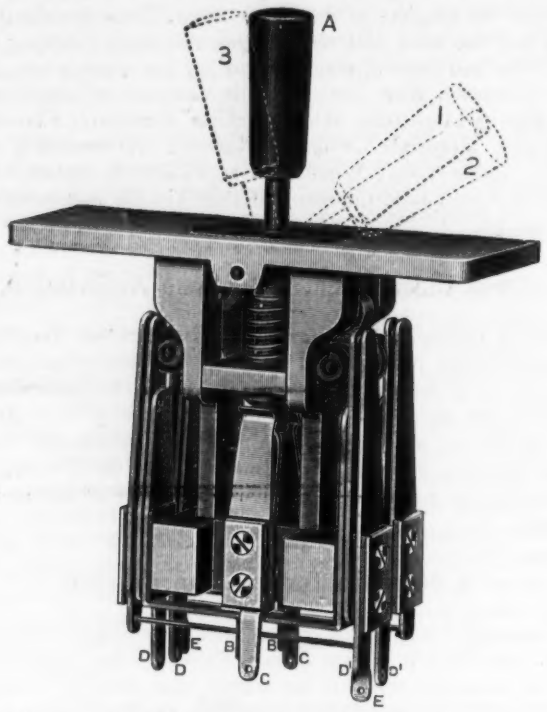
Utica Street Railways.

The Utica Belt Line street railroad, of Utica, N. Y., has passed into the hands of a syndicate represented by Horace E. Andrews, of Cleveland. The transfer was made by John W. Boyle, the president of the road, who represents a controlling interest of the stock. The purchase price was about $500,000. The Belt Line Road consists of four suburban lines, and six different lines running throughout the city. The company also has franchises for extending its New Hartford line about five miles, connecting with prosperous villages south of Utica. The company operates about 75 cars. The Andrews syndicate recently purchased the Bleecker Street Railroad. Its intention is to build an electric line from Rome to Little Falls, a distance of 37 miles, running parallel with the New York Central tracks. Engineering corps are now at work, and active work on the extensions will be begun within a few weeks. Among those interested with Mr. Andrews are the Westinghouse Electric Company, Mr. Archbald, a son of John D. Archbald, of New York; Paul T. Brady, of Syracuse, and others. It is understood that Mr. Andrews will take personal charge of the road.

Combined Telephone Ringing and Listening Key.

An ingenious union of several functions in one lever is illustrated in the accompanying cut, which shows a combined ringing and listening key, just brought out by Couch & Seeley, the telephone manufacturers, of Boston, Mass. As our telephonic readers are aware, considerable ingenuity has been employed in this direction, and the present device is regarded as a distinct advance, the three important "tricks," if so simple a word may be used, being concentrated into the easy capacity of the one lever—listening in, calling and ringing back.

Referring to the cut, *A* indicates the lever in normal position. When a call comes in the operator throws the lever forward to position 1. At the same time the same forward motion inserts the answering plug into the jack of the subscriber, calling "Number, please," "1105 Main." She picks up the calling plug, inserts it into 1105, carries the lever forward to position 2, and then throws



COMBINATION TELEPHONE KEY.

the generator direct to line. On removing the hand from the lever it flies back to "listening," and a slight touch restores it to normal. The operator rings back by bringing the lever toward her. The only place where the lever will stay is at normal and listening in.

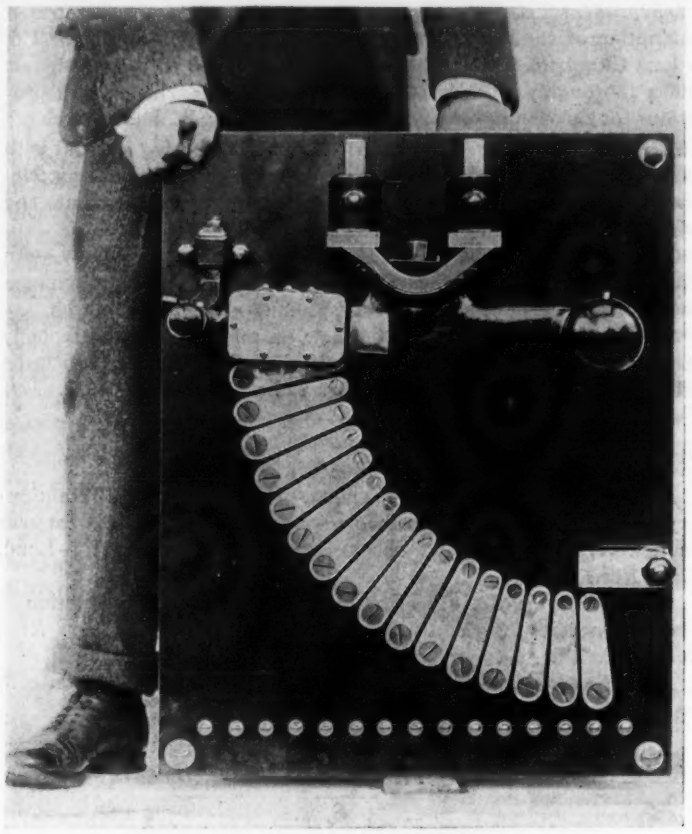
It is said that no mechanism gets harder work than the ringing and listening key on a telephone switchboard, and this has been built to stand the racket of the most severe use. It has been tested and examined on several of the largest exchange boards in the United States, and the comments of their experts have been uniformly very favorable, in regard to operation, workmanship, etc. All the contacts are platinum, and the phosphor bronze springs are shaped and mounted in such a way as to insure permanent adjustment, resulting in a device of superior merit and endurance.

A 150-H. P. Motor Starter.

We illustrate herewith a 150-hp motor starter manufactured by the Ward Leonard Electric Company, of Bronxville, N. Y. This motor starter is very compact for a starter of such large size, and is extremely substantial, being entirely enclosed in a solid iron case excepting the slate front which carries the switch parts. The company has sent a large number of these starters to foreign customers. The illustration shows one of a lot, which is to be used in practical operation in connection with the exhibit of D. Bruce Peebles & Co., at the Glasgow Exhibition in May. In series with each of these starters will be a Ward Leonard circuit breaker, which will automatically open the circuit when the supply voltage is cut off and also whenever the current exceeds a predetermined maximum.

The illustration shows the height and width of this starter as compared with a man of ordinary size. The depth over all is only about 1 ft., so that the total space occupied is extremely small when compared with the open coil type. The resistance is in the form of a thin ribbon made of nickel-copper alloy, the ribbon being 4 inches wide. This ribbon is embedded in a mass of pure white quartz sand, which entirely fills the cast-iron box. These starters are guaranteed to stand for one minute a current which is 50 per cent greater than the full-load current of the motor. The double-pole circuit breakers are of the usual Ward Leonard type, making it impossible to close the circuit when an excessive overload or short circuit exists.

This combination of starter and circuit breaker makes a highly desirable one for use with large motors, as the combination is perfectly fireproof and also perfectly "fool-proof," and the extremely large overload capacity makes the starter practicaly indestructible. The contacts are also extremely large, and are renewable. There are three entirely independent contact shoes, and when the starter is in its operating position the contact lever is automatically short circuited by means of a large switch of the "laminated leaf" type.



150-HP MOTOR STARTER.

Electrically Locked Letter Boxes.

A number of new electric letter boxes have recently been put up on Pennsylvania Avenue, Washington, D. C. These boxes are provided with comparatively simple duplicate locks. The lock is operated by the joint use of an electro-magnet and the mail collector's key. The boxes along the mail route are numbered. Each box on the route is connected electrically with a clock-like apparatus at the post office, in charge of the electric mail route operator. All the electric cables used are in the ducts of the local electric light company, which supplies the small amount of current required for operating the letter-box system. The central station apparatus controls the operation of the first letter box on each route. After that box has been opened, it automatically closes the circuit between it and the second box, setting it so that the collector's key will unlock it.

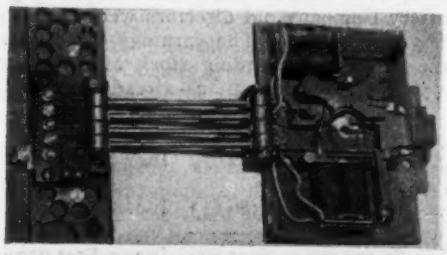
The operator at the post office having allowed the collector the specified time to reach the first box on his collecting route, presses an electric button and causes the electro-magnet in the box lock to draw back an obstructing metal bar and permit the lock bolt to slide back when the mail collector's key is turned in the lock. Both the opening and closing of the letter-box door registers the number of the box on the time card of the clock. The route is now independent

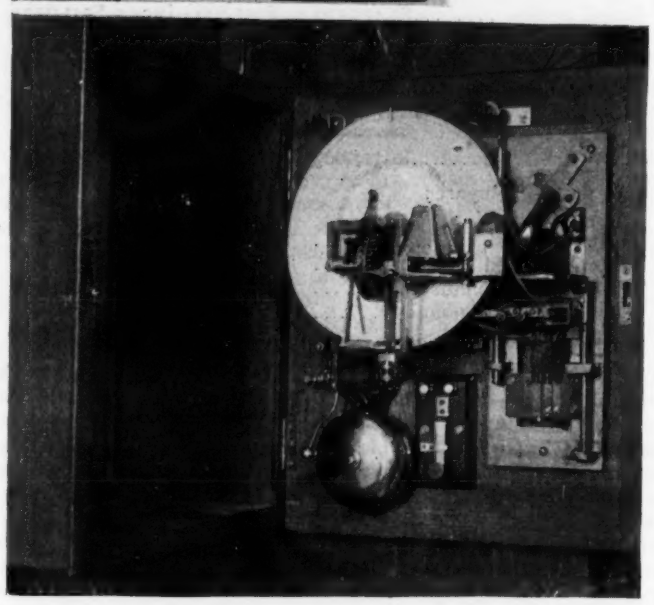
of "central," since the opening of this box has set the electric lock in the next box. No other box but No. 2 can be opened. The box just closed is barred against the key. It is compulsory, therefore, for the collector to visit the letter boxes in the prescribed order.

It is impossible to skip collecting from any box or boxes on the route to make up any wasted time. The registration on the clock records the time taken to reach the route, the time each box remained open, the time occupied covering the distance between boxes and the total time spent on the route. It is claimed that this system effectively checks loitering, and careless collecting. It is practically a guarantee to business men that their important letters can be deposited in letters boxes and be collected at the proper time without delay.

The electric-locking device permits the collector to ring an electric bell in the clock, the number of rings according to code transmits one of a few important messages. The duplicate lock affords a protection against thieves.

This apparatus of the Williams Electric Dead Lock Company was





FIGS. 1 AND 2.—LETTER-BOX LOCK AND AUTOMATIC ELECTRIC LOCK AND TIME REGISTER.

installed by Mr. Frederick Williams, its inventor. This system is working satisfactorily in the post offices at Boston, New York and Philadelphia. It can be easily installed in hotels having annunciator and call-bell wiring. Its use will prevent the unlocking of rooms by hotel thieves, as the lock will be under control of the clerk, who will set the locks for the guests' keys when requested by them.

The robbery of stores by employees having duplicate keys can be prevented by the use of this lock. In penal institutions its application will prevent doors being unlocked out of prescribed hours, as the control of the locks will be directed from the superintendent's office.

Automatic Motor Starter.

The automatic motor starter shown in the accompanying illustration is designed for starting non-reversing motors for elevators of the double-belt type. The circuit-closing switch of the starter is made up of four blades having parallel action and carbon break tips. The starter is operated by a rope fastened to the sheave wheel, as shown in the cut, which passes up the hatchway and can be manipulated from any floor. When pulled in one direction the motor starts, and when pulled in the other direction the circuit is completely opened. The two binding blocks at the right of the wheel are terminals for a lamp circuit to each floor, and so connected at the starter that no currents flows when the motor is at rest; the lamps burn

AUTOMATIC ELEVATOR MOTOR STARTER.

only when the motor has reached full speed, and thus indicate to the operator that the elevator can be started. Everything about the starter is interchangeable.

The motor starter described is made by the Three Rivers Electric Company, Three Rivers, Mich.

Pendant Chain Pull Socket.

The device illustrated herewith is intended for use in situations where the ordinary key socket is not within reach. From the side of the socket is a pendant chain which, on being pulled, turns the current on and off, as the case may be, and another pull produces the

CHAIN-PULL SOCKET.

opposite result. The mechanism of the device is simple. One pull of the chain turns the switch one-half a revolution, and either closes or opens the circuit, and the next pull completes the revolution with the reverse effect. The contact points are frictional, and are kept smooth and bright. These sockets are fitted with Edison, T. H. and Westinghouse bases, and are made by Mr. Harvey Hubbell, Bridgeport, Conn.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The money market was nominal, call money closing at 2@2½ per cent. Time money closed at 3¼ per cent for 60 days to 90 days, 3½ for 4, 5 and 6 months. There was a moderate supply of mercantile paper and a fair demand; the closing quotations being 3½@4 per cent for 60 to 90 days' indorsements, 4@4½ for choice 4 to 6 months single names and 5 for others. In the stock market prices advanced and speculation broadened, and there was large buying of securities for investment. The assured success of the United States Steel Corporation caused great activity and marked advance in steel stocks, while other industrials received bullish attention. The leading railroad stocks and specialties closed with further advances. There was considerable activity in electric tractions. During the week these stocks were affected by reports of the Vanderbilt interests buying Brooklyn Rapid Transit stock, also by rumors of the buying of Manhattan Railway and Brooklyn Rapid Transit stock by Metropolitan Street Railway interests. The sales of Metropolitan aggregated 67,031, which is the largest number recorded for several weeks; the highest point reached was 168¾, and the lowest 162¾, closing at 163⅝. There was heavy buying also in Brooklyn Rapid Transit, the total number of shares sold being 269,700. The movement of prices of this stock was on a higher level than those of the previous week, the closing price being ⅜ points greater than that of the week previous. Among the electric stocks General Electric scored a net advance of 4½ points on rather narrow trading. There was some extraordinary activity in Western Union, which closed with a net increase of 1⅛ points, 28,150 shares having changed hands during the week. The week's market in outside securities was the most active in the history of trading on the "curb," sales of the United States Steel securities alone footing up between 500,000 and 1,000,000 shares. The prices fluctuated after the first rapid advance, the net gain for the week on the common stock being 3½ points, and preferred 8¼. Less interest was shown in the traction and electric list. Following are the closing prices at New York, Boston, Philadelphia and Chicago:

NEW YORK.

	Mar. 16.	Mar. 23.		Mar. 16.	Mar. 23.
General Electric	211½	215	Electric Vehicle	15	15
Brooklyn Rapid Transit	82⅜	82¾	Electric Vehicle, pfd	25	25
Metropolitan Street Ry	167⅜	163⅜	General Car	2	2
American Tel. & Cable	—	97	Illinois Elec. Veh. Tran.	1	1
Western Union Tel	88½	88⅜	Hudson River Tel	120	—
American Dist. Tel	36½	36	N. E. Elec. Veh. Tran.	2⅞	2⅞
Commercial Cable	—	160	N. Y. Elec. Veh. Tran.	4	4
Electric Boat	24	24	Tel. & Tel. Co. of Am.	6	7
Electric Boat, pfd	50	51	N. Y. & N. J. Tel.	178	—
Electric Lead Reduc'n	5⅛	5			

BOSTON.

	Mar. 16.	Mar. 23.		Mar. 16.	Mar. 23.
New England Telephone	—	139	Erie Telephone	53½	50¾
Mexican Telephone	3¼	—	General Electric, pfd	—	192
Westinghouse Electric	62	62	Am. Tel. & Tel.	160	169
Westinghouse Elec., pfd.	71	71	Boston Electric Light	—	—

PHILADELPHIA.

	Mar. 16.	Mar. 23.		Mar. 16.	Mar. 23.
Electric Storage Battery	72	72	Philadelphia Elec	6	6⅛
Elec. Storage Bat., pfd.	76	74	Pa. Electric Vehicle	*1	½
Elec. Co. of America	8⅜	8⅝	Pa. Elec. Veh., pfd.	*¾	½
General Electric Auto	—	—	Am. Railways	38½	38

CHICAGO,

	Mar. 16.	Mar. 23.		Mar. 16.	Mar. 23.
Chicago Edison	154½	154½	Chicago Telep. Co.	260	265
Chicago City Ry	270	260	Union Traction	16	15
National Carbon	15¾	15¾	Union Traction, pfd.	56½	56½
National Carbon, pfd.	82½	82	Northwest. Elev. Com.	39	39

*Asked.

A DEAL AT ELMIRA, N. Y.—It is stated that the Mutual Life Insurance Company has disposed of its interests at Elmira, N. Y., to a syndicate composed of New York and Elmira capitalists. The amount involved is supposed to be above $4,000,000. The syndicate will now own all the franchises and all of the public utilities in Elmira, with the exception of the telephone and telegraph franchises. The property which has been disposed of consists of the Elmira Water Works, the Maple Avenue Street Railroad, the West Water Street Railroad, the Elmira & Horseheads Street Railroad, the Elmira Gas Company, the Elmira Illuminating Company, an electric light concern, the old Interstate Fair Grounds, now known as the Maple Avenue Driving Park, and Rorick's Glen Park. These street railways and the water works system will be consolidated with the West Side Railroad system and the Elmira Heights Water Company, already owned by the local Elmira capitalists interested in the deal. Extensions and improvements are to be made at once as a result of the consolidation.

DIVIDENDS.—The New York Metropolitan Street Railway directors have declared the regular quarterly dividend of 1¾ per cent, payable April 15. United Gas Improvement Company has declared a quarterly dividend of 2 per cent, $1 per share. The Union Traction & Electric Company, of New Jersey, has declared a dividend of 1 per cent. The Boston Electric Light Company directors have declared a regular quarterly dividend of $2 and an extra dividend of $1, payable April 15 to stockholders of record April 1. Directors of the Newton, Mass., Street Railway have declared a quarterly dividend of 1½ per cent, payable April 1. This is a reduction of ½ per cent. The company has paid quarterly dividends of 2 per cent for the past eight years. Directors of the American Telephone & Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable April 15.

ELECTRIC STORAGE BATTERY.—At the annual meeting of the Electric Storage Battery Company old directors were re-elected. Of 160,000 shares 140,665 were voted. The earnings for 1900 are about 7 per cent on the present outstanding stock of $16,875,000. The annual report for year ended Dec. 31, as already forecast in these pages, shows:

	1900.	1899.	Changes.	
Gross	$3,309,443	$2,122,679	Inc.	$1,186,764
Mfg. purchase and instal. charges	1,861,923	1,186,813	Inc.	675,110
Gross profits	$1,477,519	$935,866	Inc.	$541,653
Fixed charges, etc.	297,779	326,781	Dec.	29,002
Net profits	$1,149,759	$609,185	Inc.	$540,574
Other inc.	168,105	315,438	Dec.	147,333
Net inc.	$1,317,865	$924,523	Inc.	$393,342

Other figures compare:

	1900.	1899.
Orders booked	$3,509,002	$3,500,996
Orders unfilled Dec. 31	1,236,947	1,378,316
Plates mfd—pounds	15,361,000	10,796,427
Plates shipped—pounds	11,688,151	8,336,739
Plates ordered—pounds	11,017,579	14,062,137

CANADIAN GENERAL ELECTRIC STOCK.—Application has been made to list the stocks of the Canadian General Electric Company on the Montreal Stock Exchange. The capitalization of the company is $1,500,000, of which $300,000 is preferred, paying 6 per cent interest. The common stock pays 10 per cent per annum, and the closing quotation in Toronto a few days ago, and where the stock has been active for some time, was 210¼. The capitalization will be increased to $2,000,000. Last year the company paid out in dividends $127,623. The Royal Electric Company, of Montreal, holds 3000 shares of Canadian General stock, which it received in payment for its manufacturing plant a short time ago. The Royal got this stock at 160, which would make its original value to the company $480,000, but since that time the value of the stock has risen until it is now worth about $630,000.

BELL TELEPHONE OUTPUT.—The net output of instruments of the American Telephone & Telegraph Company indicates a rapid development in the telephone business. The net gain of subscribers for the month of February throughout the country is not far from 22,000, as against 16,000 for the same period last year. The net gain of subscribers for the months of January and February is estimated at 43,000, as against 35,000 for the same period last year. Nearly every Bell subsidiary company in the country has recently increased its capital stock or authorized bond issues, and this year promises to be one of great development.

ELECTRIC COMPANY OF AMERICA.—Notices are issued for the annual meeting of the Electric Company of America to be held April 23. The profits of the year show about $410,000. The year's dividend, $1 per share, is on nearly 400,000 shares outstanding, and the surplus over the dividend in 1900 is understood to be about $20,000.

WORCESTER TRACTION.—The stockholders of the Worcester Traction Company ratified the action of the directors in selling the stock, franchise and plant of the company to Vermilye & Co., of New York. The company is capitalized for $5,000,000, of which $3,000,000 is common stock and $2,000,000 preferred.

PHILADELPHIA BELL TELEPHONE will vote May 21 to increase from $6,000,000 to $8,000,000.

GENERAL ELECTRIC at 216 leads the "risers" in the stock market, with a gain of $74 since election and $45 since Jan. 1.

BROOKLYN RAPID TRANSIT.—The Brooklyn Rapid Transit Railroad reports gross earnings for February of $843,394, an increase of $26,112 as compared with the same month of last year, and net $258,933, an increase of $41,917. For the eight months ending Feb. 28 the gross earnings were $7,899,100, an increase of $254,048, as compared with the corresponding period of last year, and net $2,748,-694, an increase of $462,836.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports to the commercial agencies during the week indicate a continuance of the healthful conditions in trade and business in general. In the iron and steel lines, manufacturers make very favorable reports, with orders on hand to carry them well into the midsummer and with an outlook for fall business, which is highly satisfactory. Export business is quiet, but enterprising American concerns are still securing fair orders for finished material, notably rails, bridges and structural work. There is a rapidly increasing demand in structural steel and building hardware, and there is every indication that with the opening of spring, building operations throughout the country will be on an extensive scale. The only line of trade in which no improvement is noticed is the textile industry. The metals are fairly steady, except tin, which is slightly lower. Copper is unchanged, and manufacturers in this country, though they are busy, have not been buying much. Lake is quoted at 16⅞@17c.; electrolytic in cakes, wire bars or ingots, at 16.35@16.45c.; in cathodes at 16.10@16.20c.; casting copper, 16⅜c. The gross railway earnings for the second week in March show a gain of 8 per cent over the same period last year. The failures during the week, as reported by *Bradstreet's*, number 231, as against 207 the week previous and 192 the same week a year ago.

TELEPHONE, TELEGRAPH & CABLE COMPANY.—The Telephone, Telegraph & Cable Company of America, at a special meeting in Jersey City on March 26, approved the resolution of the board of directors providing for a decrease of the capital stock from $30,000,000 to $9,000,000. The decrease is to be effected by reducing the par value of a share from $50 to $15. Two hundred and nineteen thousand four hundred shares were represented, and the vote in favor of decreasing the capital stock was unanimous. William J. Latta, organizer of the company, was not present, and nothing regarding the company's plans for the future was divulged. The Telephone, Telegraph & Cable Company of America was organized about 16 months ago, and $5 a share was paid, and later $7.50 additional became payable. After the company gave up control of the Erie Telegraph & Telephone Company it has not done much to widen its field.

CUBA AND MEXICO.—The Compania de Ferrocarriles del Distrito Federal de Mexico (the City of Mexico Tramways Company) and the Havana Electric Company continue to be among the largest purchasers of equipment and supplies. Last week's shipments include 400,000 lbs. of copper trolley and feeder wire for the Mexican road. The trolley wire was manufactured by W. A. Clark, of Bayway, N. J., while the feeder order was executed by the Holmes, Booth & Haydens Company, of this city. The shipment, which was made through the Morris Electric Company, of New York City, was valued at some $80,000. Pending shipments to Havana comprise an $18,000 lot of miscellaneous supplies. The International Coal Company, of Philadelphia, has just shipped two cargoes of bituminous coal for the Cuban road, amounting to 6200 tons.

THE PIESA LESA ELECTRIC LIGHTING STATION at Lima, Peru, which at present is operated by hydraulic power, is to be equipped with a steam plant, as under existing conditions the frequent scarcity of water does not permit of running regularly. Westinghouse, Church, Kerr & Co., of New York City, have been awarded the contract. There will be a 200-hp boiler built by the Babcock & Wilcox Company. The heating apparatus will be manufactured by the National Pipe Bending Company, of Bridgeport, Conn. The pumps are to come from the Deane shops of the International Pump Company, while the condensers will be of Worthington make. The contract also calls for a 16-inch Westinghouse compound engine, together with the requisite piping and fixtures to make a complete plant. The Lima concern is equipped with four 150-kw generators manufactured by the General Electric Company.

THE NIAGARA RAILWAY SUPPLY COMPANY has been incorporated with a capital of $500,000 to manufacture the McPherson safety frog and switch. The incorporators are De Lancy Rankine, of Niagara Falls; Charles R. Huntley and Robert W. Pomeroy, of Buffalo. The company will locate its factory on the lands of the Niagara Falls Power Company, having selected a site at the foot of Iroquois Street. The plant is expected to be an extensive one, for the company will also make other railway supplies outside of the frog and switch above referred to. New York and Canadian capitalists are interested in the company, and it is stated that other names will be added to the list of directors. Ground will be broken for the factory as soon as the frost is out of the ground, the hope being to get the plant in operation by July or thereabouts.

THE CHICAGO PNEUMATIC TOOL COMPANY, of New York, has secured an order through Takata & Co., of 10 Wall Street, for supplying a number of riveting, caulking, chipping, drilling and other pneumatic tools, which are to be installed in Japanese dockyards. The order also requisitions for a large air compressor, which will be built by the New York Air Compressor Company, of New York City. The equipment is to be driven by a 45-hp electric motor manufactured by the Westinghouse Electric & Manufacturing Company. The Chicago Company is about to ship two complete plants consisting of various pneumatic tools, air compressors and motors, to Brazil. The motors will be 15-hp each. They are being furnished by the General Electric Company.

AUTOMOBILES FOR THE TRANSVAAL.—Mr. A. W. K. Peirce of the General Electric Power Company, Limited, Germiston, Transvaal, South Africa, writes us that he would be glad to receive particulars from the manufacturers of electric automobiles in America, as to the vehicles they make. He states that at the present time a horse in Africa eats about $45 worth of provender a month, with every probability of an increase rather than a decrease in the cost. It appears to him, therefore, that under the conditions prevailing at his power station, there is a good field for the "auto," and he would like to hear from our manufacturers on the subject as soon as possible.

THE CASE MANUFACTURING COMPANY, Columbus, Ohio, report that they have just closed contracts with the following parties: James Leffel & Co., Springfield, Ohio, for one 15-ton 50-ft. span electric traveling crane; Henry D. Perky, Niagara Falls, N. Y., for two one-ton electric traveling cranes; United States Cast Iron Pipe & Foundry Company, Addyston, Ohio, one 25-ton electric traveling crane; William R. Trigg Company, Richmond, Va., one 3-ton 3-motor electric traveling crane.

THE MORRIS ELECTRIC COMPANY, of New York City, states that work begins on its new East Orange factory within the next few days. Elmer P. Morris says that he hopes to commence the execution of orders there inside of six weeks. There is to be a brass foundry plant. A number of molding machines are about to be ordered as well as ten furnaces. The steam power plant has been ordered of the Atlas Engine Works, of Indianapolis, through the Edward P. Hampson Company, of New York City.

THE NATIONAL GAS & CONSTRUCTION COMPANY, of Philadelphia, is about to place contracts for the equpiment of the new city lighting station at Norfolk, Va. The equipment will consist of two engines of 310-hp, each direct connected to 250-kw alternating-current generators. There will also be a complete steam plant of 620 horse-power. These contracts will entail an expenditure of some $30,000.

THE CHAPARRA SUGAR COMPANY, of 109 Wall Street, New York City, which is placing several important contracts for machinery, equipment, etc., for its plantation in Cuba, has given an order to the General Electric Company for the furnishing of generating apparatus to supply electric light in the factory buildings. The engine end of the order will be undertaken by the Harrisburg Foundry & Machine Company.

MACHINE TOOLS.—The Cincinnati department of the Marshall-Huschart Company, is now located in new quarters. Among the machine tools purchased were two from the Cincinnati Milling Machine Company, two from the Bickford Drill & Tool Company, and a lathe, some drill presses and planers from the Bradford Machine Tool Company.

AMERICAN JESSOP STEEL.—A cable dispatch from Sheffield, England, of March 12, says: At the annual meeting of William Jessop & Sons to-day it was announced that the directors are about to establish works for certain branches of their business in the United States.

THE GALENA OIL COMPANY, of Galena, Pa., is at present making some substantial purchases of machinery, equipment, etc., in view of an extension to its plant. Westinghouse, Church, Kerr & Co., of New York City, have received an order for a 200-hp gas engine for electrical purposes.

THE SHELBY STEEL TUBE COMPANY, with a capital of $15,000,000 and operating more than half a dozen plants in the States of Connecticut, Pennsylvania, Indiana and Ohio, will soon, according to report, make its principal headquarters in this city.

BRADFORD MACHINE TOOL COMPANY.—The Bradford Machine Tool Company, Cincinnati, Ohio, reports a foreign demand for its machines, principally from Portugal.

NIAGARA POWER.—If a bill now before the New York Legislature becomes law, it will give Niagara Falls a new power company, the name selected for which is the Lower River Power & Water Supply Company. The capital is $5,000,000. The incorporators are Commodore P. Vedder, Tunis G. Bergen, William Williams, Charles E. Hotchkiss and DeWitt V. D. Riely, of New York; George W. Knox, Patrick F. King and James S. Simmons, of Niagara Falls. The company under the provisions of the bill is authorized to construct and maintain pipes or tunnels through or under the city of Niagara Falls and the town of Lewiston, and the streets and highways thereof, extending from such point or points outside of the lands of the New York State Reservation, on the easterly side of the river. In other words, this new power company seeks the right and a franchise to construct a tunnel from a point below the lower steel arch or railway bridge, at the whirlpool rapids, through the point of land at the whirlpool on the New York side. This tunnel would begin just below the railway bridges and have its outlet near the Devil's Hole, the drop of level being about 80 ft., it is understood. The power station would be at the Devil's Hole, and the power developed would be used in the northern section of the city in all probability. The press dispatches announce that the company seeks to be a rival of the company that has rights on the Erie canal, but the company has no such intention or aspiration. The company feels that the cost of constructing the tunnel would be greatly reduced by the fact that electrically operated dump cars could be run right into the tunnel from the line of the Gorge road. The excavated rock could be easily disposed of in strengthening the roadbed of the Niagara Gorge road, and it would not have to be carried far beyond the upper entrance to the tunnel; in fact, such a supply of rock would be valuable to the Gorge road, it is believed.

ENGINES AND GENERATORS FOR ST. LOUIS.—The Supply Commissioner, March 15, opened bids for furnishing the water department with generators and engines for installation at the Baden plant to manufacture electricity for lighting the several buildings there, and at Bissell's Point, and also for furnishing power to operate an electric railway between the two stations. He also received proposals for furnishing a double motor equipment. The bids received were based upon several propositions. On furnishing one 20-kw alternating-current generator and Pelton waterwheel, direct connected, there were three bids—Westinghouse Electric & Manufacturing Company, $1,785; General Electric Company, $2,040, and Stanley Electric Manufacturing Company, $2,205. Three firms submitted bids for furnishing one 100-kw alternating-current generator and engine, direct connected, as follows: Westinghouse Electric & Manufacturing Company, $5,840; General Electric Company, $6,007, and Stanley Electric Manufacturing Company, $6,325. The third proposition on which bids were received was for furnishing one 100-kw direct-current generator and engine, direct connected. There were four bids for this contract, two firms presenting two bids, based on different propositions. The bids were as follows: General Electric Company, $4,655; Crocker-Wheeler Company, $5,500; Westinghouse Electric & Manufacturing Company, $4,476 and $4,687, and the Northern Electric Manufacturing Company, $4,568 and $4,679. For furnishing the motor-car equipment there were but two bidders—the General Electric Company, $1,600, and the Westinghouse Electric & Manufacturing Company, $1,787.

THE CASTNER ELECTROLYTIC COMPANY has made a contract with the Niagara Falls Power Company for an additional block of 5000 electrical horse-power. It will be recalled that the Castner Electrolytic Company is an English syndicate that bought out the Mathieson Alkali Works located on the lands of the Niagara Falls Company. The power just contracted for is to supply very extensive additions to be made to the output capacity of the works. Several new buildings will be erected on the east side of the plant, the style of architecture and general appearance to be similar to the buildings of the present works. The company is now using 2000 electrical horse-power, and the output is about 300 tons of caustic soda and bleaching powder a week. When the extensions have been completed and the installation is in full operation, the output of the plant will be about 1000 tons a week, or more than treble what it now is. A portion of the new block of power is to be furnished in November next, while the balance must be ready by January next. It is evident from this that the new buildings are to be erected with all possible speed. The number of hands employed at present is 240, but the payroll will have 700 names on it when the works are extended. In their finished state the buildings will cover over 10 acres of land and the expenditure on the additions will be about $500,000.

NIAGARA PLATING INDUSTRY.—A consolidation of the business interests of the Niagara Silver Company, of Niagara Falls, and William A. Rogers, of New York, has been effected, the new firm taking the name of William A. Rogers, Limited, and being incorporated under the Ontario Companies' Act, with a capital stock of $1,350,000. Both parties to the consolidation are interested in the manufacture and sale of silver-plated ware, the Niagara Silver Company being a tenant of the Niagara Falls Hydraulic Power & Manufacturing Company, and a consumer of electric power. The directors are S. J. Moore, of Toronto; A. E. Ames, of A. E. Ames & Co., bankers, of Toronto; Hon. W. Caryl Ely, president of the International Traction Company, of Buffalo; Robert Kilgour, vice-president of the Canadian Bank of Commerce of Toronto; James L. Morrison, president of the Niagara Silver Company, of Toronto; Hon. Charles H. Duell, ex-Commissioner of Patents, Washington, D. C., and Wm. A. Rogers, of New York. The officers are: President, S. J. Moore; vice-president, A. E. Ames; general manager, William A. Rogers. There will be a considerable extension of the business.

THE NATURAL FOOD COMPANY, of Niagara Falls, has made a contract with the Niagara Falls Power Company for 2500 electrical horse-power for the operation of the new factory building now in course of erection on Buffalo Avenue in that city. The Natural Food Company are the makers of shredded wheat biscuit, and the plant now in building at the Falls is destined to be one of the most wonderful factory structures in the country. In length it will be 542 ft., width 66½ ft., and height six stories. The skeleton will be of steel and the walls of brick. It is expected that it will demonstrate the perfection of factory construction in every department. Henry D. Perky is the head of the company, and the day that he journeyed to the Falls is marked by a white stone. A very large force of men is at work rushing the plant to completion.

POWER EQUIPMENTS.—The Triumph Electric Company, Cincinnati, Ohio, is now booking orders for power equipment for next August and September deliveries. A recent contract secured is for the equipment of the Newport Rolling Mills, a 100-kw generator and four motors, aggregating 40 horse-power. Other orders are for one 21-kw direct-connected machine for Tampa, Fla.; one 50-kw for Grand Forks, Minn.; one 17½-kw direct connected, and a 3½-hp motor for the University of Cincinnati; one 200-kw direct connected and one 5-hp crane motor and one 2½ for the Globe-Wernicke Company, Cincinnati; four motors for the Bradley & Sorin Company, equipment for two new Ohio River steamers; two 100-kw belted machines for the Union Hill, N. J., lighting plant, and one 20-kw direct-connected machine for the Conshohoken, Pa., lighting plant.

THE LEHIGH VALLEY RAILROAD is making a number of improvements. One of the most expensive of these is the installation of the automatic electric block-signal system along its entire main line. This system will be finished by June 1. When it is completed the Lehigh Valley will be operated under the automatic electric block-signal system from New York to Buffalo, and will be the first of the trunk lines to have established this costly but valuable improvement along its entire main line.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, Pa., manufacturers of the chloride accumulator, announces that a sales office has been established at Cleveland, Ohio, and Mr. E. V. Stebbins, formerly of the Philadelphia staff, has been placed in charge as manager. The office will be located in the New England Building and all business from that territory will be handled by Mr. Stebbins.

ELECTRIC POWER IN BREWERY.—Contracts for changing the power of the Anheuser-Busch Brewing Company from steam to electricity have been let to a St. Louis firm, and work on the new equipment will be commenced at once. A new power building is to be erected near the present lighting plant. It is estimated the change will cost between $200,000 and $300,000.

MR. C. LORENZ, S. O. 26 Elisabeth Ufer, Berlin, Germany, would like to undertake for Germany and Russia the handling of American specialties and novelties in the line of telephony, telegraphy, railway signals, stock tickers, etc. For some 20 years past he has sold such apparatus to the German railways, post office, military authorities, etc., and is therefore in a good position to introduce articles of merit.

PROPOSALS FOR ELECTRIC LIGHT PLANT.—Mr. E. M. Dawson, chief clerk of the Department of the Interior, Washington, is preparing to invite proposals for an electric light plant, for which an appropriation of $74,000 was made by the last Congress. The plant will supply light to the Patent Office Building, the old Post Office Department Building and the Pension Building.

RAILWAY MATERIAL.—Manager McCallum, of the Electric Railway Equipment Company, Cincinnati, Ohio, reports an excellent inquiry for electric railway material, both domestic and foreign. Some heavy shipments have just been made to England. There is some inquiry from South America, also Japan and China.

THE DIEHL MANUFACTURING COMPANY, of Elizabethport, N. J., has just filled a very large order for ceiling fans and electroliers of unique and magnificent design, to be installed in the Imperial Palace at Formosa.

General News.

THE TELEPHONE.

LONDON, KY.—A. W. Huggins is organizing a telephone company here.

CARLISLE, ARK.—E. A. Wilson and others have organized an independent telephone company.

ANSONIA, CONN.—The Ansonia Telephone Company has increased its capital stock to $25,000.

MIDDLEBOURNE, W. VA.—The Inland Telephone Company contemplates making some improvements.

DRY RUN, MD.—The Dry Run Telephone Company has been organized. It will build to Williamsport.

CARLISLE, ARK.—Mr. E. H. Wilson desires prices and catalogues of telephone equipment and supplies.

CHARLOTTE, N. C.—Negotiations are said to be under way for the construction of a telephone line between Clinton and Whitmore, S. C.

NEW YORK CITY.—The general offices of the Knickerbocker Telephone & Telegraph Company have been removed from 418 Broome Street to 100 Broadway.

INDIANAPOLIS, IND.—The Star Telephone Company of French Lick has been incorporated; capital, $2,000; directors: L. Ellis, Harry Roland, and J. L. Sutton.

KNOXVILLE, TENN.—The Southern Telephone Construction Company has been incorporated by W. O. Rhode, W. S. Roberts and J. W. Sneed. Capital, $10,000.

KNIGHTSTOWN, IND.—The Henry County Telephone Company, organized at this place, has disorganized on account of the low rural rates offered by the Bell Company.

TRENTON, N. J.—The Southern Telegraph Association has been incorporated; capital, $100,000. Incorporators: Sanford Duncan, John T. Lands and George H. B. Martin.

ALBANY, N. Y.—The Livonia Telephone Company of Livonia has been incorporated; capital, $1,000; directors: E. A. Bronson, C. E. Hartson, and W. B. Thurston, Livonia.

PORTAGE, WIS.—The People's Telephone Company, which owns exchanges at Rio, Wyocena, Cambria, Randolph and Fox Lake, contemplates establishing exchanges at Beaver Dam and Juneau.

INDIANAPOLIS, IND.—Articles of incorporation have been filed with the Secretary of State by the Star Telephone Company, of Shoals, and the Warrington Telephone Company. A system will be established in each town.

LONDON, KY.—A. W. Huggins, of this place, has secured right of way for a telephone line to Manchester. A stock company is being organized. As soon as completed to Manchester the line will be extended to Hyden and on to Hazard.

HARTFORD CITY, IND.—The Central Union Telephone Company, which is asking for a new franchise, has announced that it will furnish telephones at 90 cents a month. The rate of the independent company is $2 and $1 a month.

SCOTTSBURG, IND.—The town board has granted a telephone franchise to each of four applicants, viz: Hoosier Telephone Company, Scott County Telephone Company, C. E. Gregory, of Sheridan, and E. E. Dougherty, of Brownstown.

DELTA, OHIO.—The Delta Telephone Company has increased its capital stock from $10,000 to $20,000. The owners of the company are Y. J. Platt, F. W. Zerman, George A. Everett, G. R. Whitehouse, C. P. Waltz and G. B. Whitehouse.

BALTIMORE, MD.—The Suburban Telephone Company has been incorporated by C. Ross Mace, John H. Sheridan, John W. Crouch, Robert C. McClintock, Joseph Dryer, Edward C. Carrington, Jr., and R. Vincent, Jr. Capital, $10,000.

BLOOMDALE, OHIO.—The Oil Belt Telephone Company is preparing to install a local exchange which will also cover the surrounding country. Long-distance service will be secured through the lines of the United States Telephone Company.

AUGUSTA, GA.—H. W. Buxton, formerly manager of the exchange of the Southern Bell Telephone Company at Augusta, Ga., has assumed charge of the local exchange in Atlanta, Ga., succeeding R. L. West, promoted to the office of division superintendent.

WHEELING, W. VA.—A telephone war between the Bell Company and the National Company is imminent. The Bell people are charging $100 a year for business telephones and $50 a year for residences. The National has placed its rates at $35 and $18 a year.

CHARLOTTE, N. C.—The telephone exchange at Ducktown, Tenn., has been purchased by the Cumberland Telephone Company and will be connected with Knoxville, Tenn. The company is also said to be negotiating for several other exchanges in East Tennessee.

COMER, GA.—The Danielsville & Homer Telephone Company expects to increase its exchange capacity from 40 drops to 100 drops. Its business outlook is encouraging. The company now has twenty-seven subscribers and began business in August, 1899 with one line.

SEYMOUR, TEXAS.—The Proffitt Telegraph and Telephone Company of Seymour, Baylor County, Texas, has been incorporated with a capital stock of $10,000. The incorporators are J. W. Proffitt, of Proffitt, Texas; J. H. Glasgow and G. G. Garrett, of Seymour, Texas.

DES MOINES, IA.—The Iowa, Minnesota & South Dakota Telephone Company, of Sioux Falls, has been incorporated with a capital stock of $100,000. The company will establish a branch office at Britt, Ia. The Iowa members of the board are T. A. Way, T. A. Potter, E. P. Healy and B. C. Way, of Britt.

HILO, HAWAII.—The Hilo & Hawaii Telephone and Telegraph Company now has 260 subscribers. The company's prospects are good. It has a switchboard capacity of 500 drops and is looking forward to additional subscribers in the immediate future. Mr. E. E. Richards is manager of the company.

GREENFORK, IND.—The Home Telephone Company, of this place, is completing a plant that will afford service to the town and to a wide section of surrounding country. The telephones are furnished at 40 cents a month, and that price includes service of the long-distance lines within a prescribed territory.

ZANESVILLE, OHIO.—All the $200,000 capital stock has been subscribed for the Zanesville Telephone & Telegraph Company, $40,000 being allotted to local investors. The larger portion of the balance is held by the Federal Telephone Company, of Cleveland. Sherman M. Granger is president of the company.

SUMPTER, S. C.—A telephone fight of interest is in progress here, where Peter Blow, of Nashville, Tenn., is seeking a franchise for a new company, and the Sumpter Telephone Company is endeavoring to hold an exclusive franchise. The City Council has considered the matter but has postponed action until some future date.

SPARTANSBURG, S. C.—A warm fight is in progress here between the Citizens' Telephone Company and the Bell Telephone Company for supremacy. The market men of the city, heretofore using the Citizens Company's telephones by agreement, have agreed to install the Bell telephones. They are now threatened with the removal of the Citizens' telephones.

BARABOO, WIS.—A company has been formed here for the purpose of building a telephone line from Lacrosse to Milwaukee via Baraboo, with a capital of $100,000. It will be known as the Badger Long-Distance Telephone Company. The officers are A. C. Gray, president; Frank T. Brewster, secretary. It is the intention to eventually extend the line to Minneapolis.

CLEVELAND, OHIO.—The Cuyahoga Telephone Company has connected up its new Broadway exchange which will take care of 600 subscribers in the Newburgh district of the city. The exchange has an ultimate capacity of 2000 subscribers. The new Shore exchange at Nottingham is to be enlarged to take care of a large territory along the lake shore outside of the city.

TORONTO, ONT.—The corporation of the city of Toronto has petitioned the Dominion government to enforce the clause in the act of 1892, providing that existing rates should not be increased by the Bell Telephone Company without the consent of the government; also, that the company be obliged to supply telephones to all persons who require and are willing to pay for the same.

CHARLOTTE, N. C.—The plant of the Queen City Telephone Company, at Charlotte, was sold at a receiver's sale March 18, the purchaser being the Curtis syndicate, of Newark, N. J. The price paid was $23,000. The plant is said to have cost over $40,000. Improvements and enlargements are contemplated. The rumor that the purchase was made for the Bell Company was denied by all parties concerned.

NORFOLK, VA.—The Southern States Telephone Company, a Maryland corporation, operating exchanges in Norfolk, Portsmouth, and Berkeley, has filed a mortgage here to the Fidelity and Deposit Company of Baltimore to secure a bond issue of $150,000, the money to be used in retiring $50,000 of a previous bond issue and $100,000 in improving and extending the company's lines hereabouts.

ERIE.—The Erie Telephone system reports its wire mileage construction in 1900 as follows: Exchange, 625 pole miles, 73,027 wire miles; long distance, 2,585 pole miles, 25,907 wire miles. Of the 98,934 miles of wire constructed during the year, 45,957 miles were put underground. On Dec. 31, 1900, the system had in operation: Exchange, 3,915 pole miles, 198,470 wire miles; long distance, 17,207 pole miles, 95,574 wire miles. Of the 294,044 wire miles, 95,906 are working underground.

RICHMOND, IND.—The Telephone, Telegraph and Cable Company of New York which owned an interest in the National Telephone and Telegraph Company, operating exchanges in 700 towns in Northern Indiana, Southern Michigan, and Northwestern Ohio, has sold its interest to H. C. Paul and C. S. Bash of Fort Wayne, Ind. The Bell Company made an effort, it is said, to get the property, but failed. The stock owned by the New York company brought $120,000.

MANSFIELD, OHIO.—The Mansfield Telephone Company, which is backed by the Federal Telephone Company, of Cleveland, has bought out the Richland County interests, including the local franchise, of the Star Telephone Company. The price paid is said to have been $18,000. The property includes 149 miles of toll lines. A new system will be installed in Mansfield. The money derived from the sale will be utilized by the Star Company in improving its exchange at Ashland, where a new system will be installed.

MILWAUKEE, WIS.—There is talk of establishing a telephone company to compete with the Wisconsin Telephone Company in this city. Mr. Kurtz, of the National Telephone Company, of St. Louis, is promoting the plan. Mr. Kurtz is the inventor of a new system, called the new multiple contact transmitter and receiver, which is said to eliminate the metallic sounds of the Blake transmitter and to make the voice more distinct and natural in tone. The company also controls a single wire underground system.

BALTIMORE, MD.—There is great activity in the extension of telephone lines in Baltimore County. The Maryland Telephone Company is extending its line to Catonsville. The County Commissioners have granted permission to the Suburban Telephone Company to build lines on the Philadelphia road, from the Baltimore City limits to the Harford County line, and on Eastern Avenue, from the City limits to Chase station; Bow Lane, from the Philadelphia road to the Belair road; on the road between Kingsville and the Belair road and the road from Franklinville to Upper Falls.

GRAND RAPIDS, WIS.—The telephone and toll lines between this city and Marshfield and Pittsville, and owned by the local company, have already proved a success, and the company has started to extend its connections. The toll line is operated in connection with the Twin City Telephone Company and will be extended to Babcock and Bethel at once, and in the spring a branch will be built to Progress and Veedum. The company has purchased the line between this city and Vesper, and in the spring this will be rebuilt. The line between Hansen and Pittsville has also been purchased, which will probably be changed to a farmers' line.

FRANKFORT, IND.—Serious telephone trouble has broken out here. The Stromberg-Carlson Telephone Manufacturing Company has filed suit here against the Central Energy Telephone Company of this city, J. H. Murphy, of Indiapolis, general manager, and the Marion Trust Company, trustee. The

action is based on a promissory note to foreclose a mechanics lien and to have a receiver appointed for the property and business. The amount alleged to be due and unpaid is $7,000. It is also alleged that the defendants are insolvent and are involved to the extent of more than $25,000. The company has just completed a fine plant and system.

CLEVELAND, OHIO.—The February report of the Contract Department of the Federal Telephone Company shows that $20,000 worth of new business has been added to the properties controlled by the company outside of Cleveland, Columbus and the United States Telephone Company, during the month of February. In January the figures were $16,600. The Federal Company has the controlling interest in the independent companies at Cleveland, Columbus, Youngstown, Zanesville, Portsmouth, Massillon, Columbiana County, Fostoria, Findlay, Lancaster, Galion, Shelby and other places. It is expected that the next few months will show a 25 per cent increase in the total number of subscribers.

ELECTRIC LIGHT AND POWER.

BURNSIDE, KY.—An electric light plant is being established here.

MIDWAY, KY.—The city contemplates establishing an electric light plant.

STATESBORO, GA.—There is some talk of establishing an electric light plant in this place.

KALISPELL, MONT.—The Big Fork Electric Light & Power Company has been incorporated with a capital stock of $100,000.

PENDLETON, IND.—The town board has decided on putting in an electric light plant, and petitions asking for franchises are being filed.

DUNN, N. C.—The Legislature has authorized the issuance of $35,000 of bonds by this city for an electric light plant and water works.

BLOOMINGTON, IND.—The new light and power company of this city has let the contract for improvements to its plant aggregating $25,000.

TOLEDO, OHIO.—The Home Heating & Lighting Company, recently organized, will erect a $70,000 lighting and heating plant on Monroe Street.

ST. CHARLES, MO.—The city's electric light system is being extended and a new 30-light power dynamo is being place in position at the power house.

GASTONIA, N. C.—An election will be held on May 6 to vote on a proposition to issue $25,000 bonds for an electric light plant and water works.

WAUSEON, OHIO.—H. H. Williams & Company have been given a contract to furnish light for three years. About 100 arc lamps will be required.

PENSACOLA, FLA.—The Escambia County Electric Light & Power Company will add new dynamos and increase its present lighting capacity one-third.

TIPTON, IND.—The City Council has decided to put in a municipal electric light plant. Plans for its construction are being submitted to contractors.

KNIGHTSTOWN, IND.—Work is well under way on a new electric light plant at this place. It will be run in connection with the water works plant.

KENOSHA, WIS.—If local capital can be interested in the plan, a new electric light and power company will be started as a rival of the present company.

RICHMOND, VA.—The General Assembly has passed an act authorizing the town of Abingdon, Va., to supply the inhabitants with water, gas and electric light.

FRANKFORT, KY.—The People's Water & Electric Light Company has been incorporated with a capital stock of $20,000 by L. I. Crawford, H. M. Stegenan and C. W. Evans.

COLUMBUS, OHIO.—The municipal electric light plant of this city is shut down and will not resume operations until an ordinance is passed by the City Council providing the necessary funds.

GRAND RAPIDS, WIS.—The Electric & Water Company, composed of citizens using electric lights and city water, has requested the city to issue municipal bonds for the building of a new system.

CITY OF MEXICO, MEX.—The inauguration of the new electric light plant of Linares, State of Tamaulipas, Mex., will take place on May 5. The event will be celebrated as a holiday by the people of that place.

TRENTON, N. J.—The Cataract Light, Heat and Power Company, capital $100,000, has been incorporated; incorporators: Harry F. Bell, Leonard J. Tyman, Ralph Turner, Leonard J. Tyman, all of Paterson, N. J.

NEWARK, N. J.—The Union Township Electric Company, principal office, Township of Union, Union County, N. J., has been incorporated; capital, $2,000. Incorporators: John Kean, Hamilton, F. Kean, Julian H. Kean, John W. Whelan.

REDFORD, VA.—The Redford Water Power Company, of Redford, has been chartered, with a capital of $50,000, to furnish water and electric power. G. M. Miles, of Redford, Va., J. H. Carper, of Pulaski, Va., and others are the incorporators.

COLLINWOOD, OHIO.—The local municipal lighting plant which was installed four months ago at an expense of $30,000 has proved such a pronounced success that the village will issue $22,000 additional bonds and will double the capacity of the plant.

TOLEDO, OHIO.—The East Side Iron Elevator Company is planning to double the capacity of its large elevator. A new engine will be put in and an electric plant installed so that any portion of the elevator may be operated by independent motors.

BUCYRUS, OHIO.—The Bucyrus Gas & Electric Light Company, which was recently incorporated with $150,000, has organized with the following officers: I. C. Baxter, president; J. G. Gormley, vice-president; Peter Young, secretary-treasurer; John Gwynn, general manager.

LYONS, N. Y.—The electric department of the Clyde Gas and Electric plant was ruined by fire on March 21. The plant was formerly owned by the Clyde Gas and Electric Company, which failed several years ago, but is now owned by Edward M. Moir of Marcellus. The loss is $10,000, fully insured.

ALLIANCE, OHIO.—The City Council has voted against the acceptance of the city lighting ordinance proposed by the Alliance Gas & Electric Company. A proposition to issue $40,000 worth of bonds for the purpose of erecting a municipal lighting plant has also failed to pass. Just what will be done is not known.

JAMESTOWN, N. Y.—In his annual report to the common council, Charles G. Sunderland, superintendent of the Jamestown, N. Y., municipal electric light plant, claims that the 300 arc lights of that city had cost only $36.36 each during the past year, on an all-night every night schedule. This is claimed to be the cheapest light secured by any city in the State.

CINCINNATI, OHIO.—The Union Light, Heat & Power Company has been incorporated at Covington, Ky., with a capital stock of $1,500,000. It will acquire and operate the gas and electric light plants of the Kentucky cities opposite Cincinnati. The incorporators are Jas. C. Ernst, Chas. E. Prior, J. Theo. Van Horne and E. W. Wetmore. Jas. C. Ernst is president.

ALBANY, N. Y.—The following companies have been incorporated: Power Installation Company of Buffalo, capital, $5,000; directors: G. F. Westcott, Wm. E. Westcott, Buffalo; Max Mauran, Niagara Falls. Lux Electric Light, Heat & Power Company of Clyde, Wayne County; capital, $50,000; directors: Chas. A. Lux, D. E. Lux and C. F. Lux, Clyde. The Gloversville Citizens' Electric Company, to supply electricity to Gloversville, Johnstown, Northville and Broad Albin, Fulton County; capital, $40,000; directors: John Begley, F. S. Sexton and Ervin Klein, Gloversville.

TORONTO, ONT.—The Canadian General Electric Company has acquired a tract of land in this city for the extension of the Canada Foundry Company's works that are now owned and controlled by the former company. Electric cranes will be installed for the handling of materials up to fifty tons weight. All machines will be operated by electricity supplied from the Canada General Electric works. The Peterboro branch of the General Electric works has been considerably extended of late, the main shop being 600 feet in length. About forty acres of ground are occupied in that city by the company.

THE ELECTRIC RAILWAY.

HOPKINSVILLE, KY.—E. B. Bassett is in the market for electric railway material.

CIRCLEVILLE, OHIO.—The village council has granted a franchise to the Columbus & Southern Railway Company.

PORTSMOUTH, VA.—All the union employees on the Portsmouth Street Railway went out on a strike on March 17.

CANTON, OHIO.—The Canton-Massillon Electric Railway is negotiating for the purchase of Myer's Lake, near this place.

FOND DU LAC, WIS.—The Fond du Lac Street Railway & Light Company is making extensive improvements in its system.

PINE BLUFF, ARK.—The Citizens' Light & Transit Company has been granted a franchise. It is capitalized at $200,000.

PENSACOLA, FLA.—The Pensacola Electric Street Railway Company will expend $15,000 for improvements and betterments.

HASTINGS, NEB.—The Hastings Automobile & Rapid Transit Company has been incorporated with a capital stock of $60,000.

BRYAN, OHIO.—A franchise has been granted to William D. Sherwood as trustee for the Northern Ohio Electric Railway Company.

COLUMBUS, OHIO.—The Grove City & Green Lawn Electric Railway has been reorganized. A. G. Grant, of Grove City, is president.

TOLEDO, OHIO.—It is stated that the Toledo, Bowling Green & Fremont Railway Company will extend its line from Jerry City to Fremont.

MILWAUKEE, WIS.—The Milwaukee & Lake Geneva Electric Railway Company has asked for a franchise to enter the city on the south side.

CLEVELAND, OHIO.—The owners of the Chagrin Falls & Eastern Railway are contemplating building a road from Chagrin Falls to Willoughby.

CLEVELAND, OHIO.—The Cleveland, Chagrin Falls & Eastern Railway Company is considering the advisability of extending its line to Warren.

YOUNGSTOWN, OHIO.—The Mahoning Valley Railway Company is planning an extension of its Lowellville line to Mahoningtown and Newcastle.

TOLEDO, OHIO.—The officials of the Toledo & Western Railway Company are considering the advisability of building a branch line through Ogden, Mich.

CLEVELAND, OHIO.—Ordinances authorizing various extensions of the lines of the Cleveland City Railway Company have been approved by the board of control.

CINCINNATI, OHIO.—The formal absorption of the Covington, Newport & Cincinnati Railway lines by the Cincinnati Traction Company is now a question of but a few days.

ZANESVILLE, OHIO.—T. H. Wheeler and E. G. Abott, representing the Zanesville, Adamsville & Coshocton Electric Railway Company, have asked a franchise for that road.

CANAAN, CONN.—A company is being organized for the construction of an electric road from the Massachusetts State line, north of here, to Bridgeport, a distance of 70 miles.

SMITHVILLE, VA.—The Charlotte & Prince Edward Electric Railway, with $100,000 capital, has been chartered. J. R. Martin, W. G. Williams and others are the incorporators.

CINCINNATI, OHIO.—The village Council of Reading has been asked for franchises by the Cleveland & Cincinnati Railway Company and the Millcreek Valley Railway Company.

WILMINGTON, DEL.—Peter J. Ford and other local capitalists are interested in a project to build a trolley road from Wilmington to Elkton, Md., by way of Newport, Stanton and Newark.

LIMA, OHIO.—The Western Ohio Electric Railway Company, which is building a line from Lima to Wapakoneta and St. Marys, is working on a right of way to extend the line to Celina.

ALBANY, N. Y.—The Scotia Traction Company has been incorporated; capital, $30,000. Directors—G. W. Lynch and William H. Delaney, New York City; H. V. Mynderse, Schenectady.

CINCINNATI, OHIO.—Thos. H. Fordyce, of Detroit, has been granted a contract authorizing the construction of an electric system for the propulsion of canal boats between Cincinnati and Toledo.

DAYTON, OHIO.—It is reported here that the deal for the consolidation of the Dayton & Xenia Traction Company and the Dayton & Xenia Rapid Transit Company will be closed within a few days.

CHARLOTTE, N. C.—A corps of civil engineers of the Cape Fear Electric Power Company has left for Buckhorn Falls. The survey necessary to the construction of the proposed dam will be made.

DAYTON, OHIO.—The Dayton & Northern Traction Company has filed a mortgage for $450,000 to the Central Trust Company of New York. The money derived will be utilized in completing the road.

CINCINNATI, OHIO.—Right of way has been granted the Cincinnati & Northwestern Railway. This will open up direct connection with the roads coming into the city through the Millcreek Valley.

TOLEDO, OHIO.—The Southern Railway Company has been asked to consider a lease on the 14-mile railroad connecting Georgetown, Midway and Versailles. The projectors want to utilize the right of way for an electric road.

KAUKAUNA, WIS.—The Fox River Valley Electric Interurban Railway Company has decided to build its line to Kaukauna city limits during the coming summer, without waiting for any further action of the City Council.

CHARLOTTE, N. C.—The directors of the Durham,(N. C.) Traction Company have approved plans for their new power house. The work of laying the tracks will be started as soon as the material ordered can be supplied.

TORONTO, OHIO.—E. E. Francye and Samuel McAdoo, of this place, and W. M. Miller, of Steubenville, representing the Toronto Traction Company, have applied for a franchise for a line from Steubenville to Toronto, and in Toronto.

BUCYRUS, OHIO.—The county commissioners have granted F. D. Carpenter and S. N. Coe, of Cleveland, an electric railway franchise from Galion to Crestline. The road will be an extension of the Ohio Central Traction Company's line.

CLEVELAND, OHIO.—M. J. Mandelbaum & Company have sold $100,000 worth of treasury bonds of the Cleveland, Elyria & Western Railway to a local syndicate. The money obtained will be used in the construction of the new Norwalk branch.

CHIHUAHUA, MEX.—The street railway lines in Chihuahua are to be converted into electric lines. A handsome new bridge has just been built across the Rio Concho to connect the two parts of the city. The new electric railway will cross this bridge.

HUNTINGTON, IND.—A $500,000 mortgage has been filed here on the Fort Wayne & Southwestern Traction Company's property by the Merchants Loan & Trust Company and Leon T. Loehr, Chicago. It is to run thirty years and bears 5% interest.

WAUSAU, WIS.—Articles of incorporation for the Wisconsin River Valley Electric Railway Company have been filed. The incorporators are Thomas F. Frawley, C. T. Bundy and Roy P. Wilcox, of Eau Claire, who are acting for Eastern capitalists.

ELWOOD, IND.—Prominent business men of this city and of Richmond, are taking steps toward organizing a stock company to construct an electric railway to connect with the Union Traction Company's system at Anderson, and to run through to Richmond.

RICHMOND, IND.—Representatives of the Dayton & Northwestern Traction Company have reached an agreement with the county commissioners of this place on a franchise asked. The company is incorporated in Ohio, and will also be incorporated in Indiana.

RICHMOND, VA.—The Westhampton Park Railway Company, with an authorized capital of $300,000, has been chartered by R. A. Patterson, W. T. Armstead and others to operate an electric line in Richmond, Manchester and the County of Hampton.

BUCYRUS, OHIO.—The Buckeye Traction Company, which is projecting a line from Bucyrus to Norwalk, has secured a franchise in Crawford County and for much of the way through Huron and Ashland Counties. Construction work will start from here at once.

ALBANY, N. Y.—The Albany Common Council has authorized the sale of a franchise allowing the Schenectady Electric Railroad Company to lay tracks in Albany. The franchise is to be sold for not less than $2,500 cash and 1 per cent per annum of the gross receipts.

URBANA, OHIO.—The Dayton, Springfield & Urbana Railway Company has announced its intention of extending its line from this city north to Bellefontaine and Kenton during the coming summer. It is stated that eventually the road will be extended to Toledo.

CLEVELAND, OHIO.—It is reported in electric railway circles here that the Adams Express Company is backing the Everett Mahler syndicate in its efforts to make through traffic arrangements to Toledo and Detroit for the newly organized Lake Shore Electric Railway.

FOSTORIA, OHIO.—The Ohio Northwestern Railway Company has been incorporated by William D. Clark, J. M. Bever, Levi Harbaugh, John A. Bradner, W. B. Marks and H. E. Bradner. Temporary capital stock, $2,000. It will build a road from Fostoria to Mungen.

STEUBENVILLE, OHIO.—The county commissioners and the village council of Brilliant have granted franchises for the extension of the Steubenville, Mingo & Ohio Valley Traction Company's line from Mingo to Brilliant. A lighting franchise has also been granted in Brilliant.

WASHINGTON, D. C.—The Fairfax, Potomac & Washington Railway Company has been chartered with $25,000 capital and principal office at Fairfax, Va., to construct an electric railway from Fairfax to Washington, D. C. J. F. King, of Washington, D. C., and others are interested.

CLEVELAND, OHIO.—The directors of the Cleveland & Eastern Railway Company are planning to build an extension east from the present terminus at Middlefield. It is probable that the extension will go to Meadville, Pa. An appropriation of $500,000 has been made for the work.

CINCINNATI, OHIO.—The Cincinnati & Lebanon Traction Company has secured a perpetual double track franchise over the Reading Turnpike for its route to Lebanon, Ohio. This will connect by electric railway the towns of Sharon, Mason, South Lebanon, and Lebanon with Cincinnati.

LANSING, MICH.—Gov. Bliss has signed the bill amending the law permitting the consolidation of electric light, street railway and gas companies, and immediately articles of association of the Muskegon Street Railway, Electric Light & Gas Companies were filed with the secretary of State. Capital, $600,000.

THOROLD, ONT.—The Niagara District, Wellandport & Dunnsville Electric Railway Company is seeking incorporation to construct a line of electric railway from Niagara Falls through Thorold, Port Maitland and the townships of Pelham, Clinton, etc. Jos. Battle and W. M. German, M.P., are interested.

OTTAWA, ONT.—The Ottawa Electric Railway Company has purchased the necessary plant at a cost of $5,000, and will commence work early next month to cast and weld the joints on its various lines. The work will be carried on at night, about 100 joints being cast welded each night at an average cost of about $5 per joint.

CLEVELAND, OHIO.—The Cleveland City Railway Company and the Cleveland Electric Railway Company have paid their license fees of $10 for each car operated this year. The former company paid on 250 cars and the latter reported 85 combination cars, 243 closed cars, 178 open cars, a funeral car and a special car; total, 508.

INDIANAPOLIS, IND.—Benson Bidwell, who claimed to be the inventor of the overhead trolley system, and brought injunction proceedings against the Indianapolis Street Railway Company for infringement and for an accounting of the profits, failed to make good his claim and the suit has been dismissed by the Federal Court.

YOUNGSTOWN, OHIO.—The Girard & Lowellville Belt Line Railway Company, of Youngstown, capital stock $15,000; the Girard, Thorn Hill & Haselton Belt Line Railway Company, of Youngstown, capital stock $10,000, and the Manufacturers' Belt Line Railroad Company, of Youngstown, capital stock $10,000, have been incorporated.

STEUBENVILLE, OHIO.—The Steubenville & Pleasant Heights Traction Company, which was incorporated recently with $150,000, has organized with the following officers: C. H. Strubel, president; George N. Henry, vice-president; George Canfield, secretary; Emmett McKee, treasurer. The above, with J. H. McKee and J. H. Maxwell, are directors.

FINDLAY, OHIO.—R. Rosenstock, of Cleveland, promoter of the Findlay & Southeastern Electric Railway, which will run from Findlay to Delaware, states that all of the private right of way has been secured and that surveyors will commence their work at once. The road will be double track the entire distance and will be constructed with the most modern equipment.

CITY OF MEXICO, MEX.—The Federal District Railway Company, which operates the electric and mule car street railway lines in the City of Mexico and Puebla, Mex., has been reorganized in London and its name changed to the Electric Tramways, Ltd. Hon. C. S. Stanhope, now in London, has been elected president of the company, and Charles Clegg manager.

TOLEDO, OHIO.—The lines of the Toledo Traction Company narrowly escaped being tied up recently by the overflow of the Maumee River. Water reached almost to the boilers of the power house, and the fuel supply became exhausted. A shutdown was avoided by the city authorities permitting the company to violate a city ordinance and switch a car of coal over the city streets during the daytime.

FOSTORIA, OHIO.—W. D. Marks, president of the City Heat & Light Company, has made a proposition to the Pennsylvania Railway Company for the purchase of an abandoned right of way between this place and Mungen. It is the intention to build an electric railway, power for which will be furnished from the local plant. A new company will be incorporated under the title of the Ohio & Northwestern Electric Railway Company. Mr. Marks is backed by Eastern capitalists.

HAMILTON, OHIO.—W. G. Wagenhals, general manager of the Mill Creek Valley Railway Company, acting for the Elkins-Widener syndicate, which has recently leased the Cincinnati lines, has made a cash proposition for the purchase of the lines of the Hamilton & Lindenwald Electric Transit Company. The property is valued at about $200,000 and it is proposed to consolidate it with the new Mill Creek Valley road, now building into Cincinnati. The proposition will probably be accepted.

WHEELING, W. VA.—The stockholders of the Wheeling & Elm Grove Railway Company have presented a plan to amalgamate the Wheeling & Elm Grove Railway Company, the Suburban Electric Company, the Suburban Light & Water Company and the Wheeling Park Association, and to issue $1,250,000 in bonds, of which $500,000 is to be a reserve fund and $750,000 to be used to retire the stock and bonds of the several companies amalgamated. Consolidation and a bond issue have been authorized.

COLUMBUS, OHIO.—The Columbus, Grove City & Southwestern Railway Company has been incorporated with $250,000, and officers have been elected, as follows: A. C. Grant, president; A. E. Appleyard, vice-president; Emmett Tompkins, secretary; John G. Webb, treasurer, and H. A. Fisher, general manager. The above, with J. S. Harshman and G. B. Darnell, constitute the board of directors. The company is the reorganization of the Columbus & Grove City Railway Company and the absorption of several other projects. The line will be extended to Morgan Station, Mt. Sterling and Washington Court House.

THE AUTOMOBILE.

THE MOBILE COMPANY OF AMERICA has opened its San Francisco agency at 316 Post Street, where a large stock of vehicles is displayed.

AUTOMOBILES IN SAN FRANCISCO.—The season is opening very favorably for the owners of automobiles in San Francisco. Several Sunday "runs" have been made by members of the California Automobile Club, on one of which they invaded Golden Gate Park. The Park Commissioners have since made additional concessions and the vehicles are now admitted to certain portions of the inclosure. It is considered only a matter of a little time when all classes of automobiles will be admitted to all parts of the parks.

NEW YORK CITY.—Plans are well under way for an automobile stage line to run acros New York City via Sixty-sixth Street. It is intended to connect the Sixty-sixth Street station of the Ninth Avenue elevated line with the Sixty-seventh Street station of the Third Avenue line. The vehicles will run through Central Park on the Converse road, connecting Sixty-sixth Street east and west. It is proposed to run five stages, each holding nine persons, and driven by gasoline power. One of the regular calling stations of the line will be the new riding academy in Sixty-sixth Street, near Central Park West. The stages are now being built at Tarrytown, and, it is believed, will be in operation early in April. A five-cent fare across town is to be charged.

NEW INDUSTRIAL COMPANIES.

ALBANY, N. Y.—The Ravena Electric Company of Coeymans has been incorporated; capital, $10,000. Directors: Aldine Nodine and S. W. Mosher, Coeymans; Nathaniel Niles, Albany.

ALBANY, N. Y.—The Electro-Chemical Engraving Company of New York, capital $17,000, has been incorporated; directors: F. E. Switzer, Benjamin Woodruff and G. V. W. Switzer, New York City.

THE AMERICAN TRANSFORMER COMPANY, with principal office at 44 Elm Street, Newark, N. J., has been incorporated; capital, $25,000. Incorporators: W. L. Kimball, Edw. B. Hawkins and Alfred G. Brown.

AUGUSTA, GA.—A. Brill, J. K. Hair, Chas. F. McKenzie, H. C. Morrison and L. J. Schaul have incorporated the Brill Electric Company, with a capital stock of $10,000. It will carry on a general electric construction business.

DOVER, DEL.—The Magneto Electric Company of New York has been incorporated; capital $1,000,000. Incorporators: Louis E. Niles, Springfield, Ill.; William S. Van Brocklin, Amsterdam, N. Y.; William H. Rower, Jr., Troy, N. Y.

THE SECURITY CONDUIT COMPANY, capital $250,000, to manufacture conduits and electrical supplies, has been incorporated in New Jersey. Incorporators: George B. McGown, George W. McGown and Charles A. Boynton, all of Jersey City.

THE COLONIAL SUPPLY COMPANY has been organized at Portland, Maine, for the purpose of manufacturing electrical appliances, with $10,000 capital stock. The officers are: President, Walter E. Nichols of Portland, treasurer, A. Glendon Dyar of Portland.

THE STANDARD ELECTRICAL COMPANY, of Danville, Va., has been chartered with a capital stock of $5,000. The incorporators are James G. Penn, president; R. L. Dibrell, vice-president, and James M. Williams, secretary and treasurer. The company will conduct a general electrical engineering and contracting business.

LEGAL.

EDISON PHONOGRAPH.—The application for a receiver for the Edison United Phonograph Company, which was made by the United States Phonograph Company, has been dismissed by Vice-Chancellor Stevens, of New Jersey, upon payment of the judgment held by the applicants and the costs of the application. The dismissal of the application was resisted by the Edison Phonograph Works, which will file an independent bill.

OBITUARY.

MR. EMILE M. SHAPE, for many years chief operator of the Western Union Telegraph Company in Milwaukee, died suddenly last week from pneumonia. He was one of the oldest and best-known telegraphers in the United States, having been attached to Gen. Grant's staff during the Civil War.

MR. LEANDER D. PARKER, for 18 years general superintendent of the Postal Telegraph Company of Chicago, died at his home in Evanston, Ill., last week. He resigned his position with the Postal Telegraph Company the first of the year owing to ill-health. He entered the telegraph service in 1855, and for the first three years of the Civil War served as a military operator. He was born in Canada in 1837.

PERSONAL.

MR. CONWAY ROBINSON is no longer connected with the Lea Electric Manufacturing Company.

MR. HANS W. BEATTIE has ceased to be treasurer of the Metropolitan Street Railway Company of New York.

MR. C. H. DUELL has resigned as United States Commissioner of Patents and will resume patent practice, it is said.

MR. R. I. TODD, formerly in charge of the Pittsburg Traction lines, has assumed the management of the operating department of the Cincinnati Traction Company.

MR. E. S. MANSFIELD, of the Edison Electric Illuminating Company of Boston, was a visitor in New York this week in connection with affairs of that progressive corporation.

MR. EDWARD WESTON, who recently caught a burgular in his room at the Waldorf, has now succeeded in trapping a blackmail confidence man there, who is now in the hands of the police.

MR. AUGUST H. KRUESI announces the approaching marriage of his sister, Miss Emily Margaret Kruesi, to Mr. Wayne Ramsay Brown, on April 9, at the First Reformed Church, Schenectady, N. Y.

MR. WARD BARNUM, formerly with the Arnold Electric Power Station Company of Chicago, has been appointed superintendent of the new Union Heat, Light and Power Company of Covington, Ky. They have under consideration an entirely new plant.

MR. F. H. NALDER, the English electrical instrument manufacturer, and Mr. P. A. Ransom, a gearing manufacturer, have arrived here and will spend two or three weeks making a tour around Canada and the United States, where they have many friends.

MR. JACOB L. GREATSINGER, a western railroad man, has been elected president of the Brooklyn Rapid Transit system in the place of Mr. C. L. Rossiter, resigned, and handsomely remembered by the board of directors. The new incumbent has a favorable record.

PROF. GEO. F. SEVER, superintendent of electrical exhibits at the Pan-American Exposition, Buffalo, has issued an admirably illustrated brochure in regard to his part of the work on that great enterprise. The pamphlet is in fact a summary of recent electrical development.

MR. A. A. KNUDSON has issued in pamphlet form his very interesting paper upon the "Cause and Effect of Electrolytic Action Upon Underground Piping Systems," read and discussed before the New England Water Works Association last December. It is quite freely illustrated.

MR. EDWARD K. GILLETTE has assumed charge of the Cincinnati office of the Stirling Company of Chicago, vice Mr. Isidor Rauh, resigned. Mr. Gillette was for eleven years identified with the General Electric Company, but has been more recently the Pittsburg sales agent of the Stirling Company.

MR. H. H. VREELAND, president of the Metropolitan Street Railway Company of New York, has a striking article on the opportunities for young men in the new business order, in the *Saturday Evening Post*. While he does not decry college education, Mr. Vreeland insists that it is by no means all. It is the man's own work and high aim that count.

MR. JOHN KILGOUR, president of the Cincinnati Street Railway Company, has been elected president and general manager of the City & Suburban Telegraph Association, which operates exchanges in Cincinnati and Hamilton. He succeeds the late George N. Stone. W. A. Blanchard succeeds Mr. Stone as director, and Mr. Kilgour as treasurer.

MR. N. C. COTABISH, the sales manager of the National Carbon Company, Cleveland, Ohio, informs us that the recent reports of the fire at their works were greatly exaggerated by the daily papers. The fire has not in any way interfered with the filling of orders, and the works were not shut down for a single hour.

PROF. S. W. STRATTON, of the physics department of the University of Chicago, returned to that city and announced that in view of the fact that he had been appointed director of the new Standardizing Bureau at Washington he would resign his professorship. His resignation will take effect either in April or July. He will go to Europe, where he will study systems of weights and measures in France, Germany, England and Austria.

MR. NIKOLA TESLA has, it is stated, ordered from the Westinghouse Company some apparatus to be used in his Atlantic Ocean wireless telegraph. Mr. Tesla states that the success of his latest enterprise is more assured now than ever before, and within the next six months his invention will be given a practical test. He hopes to prove that it is not beyond the range of possibility to establish communication across the ocean without the aid of wires.

MR. G. W. ALDRIDGE.—An announcement is made that George W. Aldridge has closed a contract with the Citizens Light and Power Company of Rochester, N. Y., and taken a considerable financial interest in the corporation, and the understanding is that he will act as general manager, not only of the Rochester concern, but of a number of other lighting corporations under the control of the Young-Brady syndicate. It is understood that the salary to be received by Mr. Aldridge will be $10,000 a year. The syndicate is headed by A. M. Young, of New York, and Anthony M. Brady, of Albany. Mr. Aldridge is well known in State politics and in canal work.

Mr. FRED J. ALLEN, of Auburn, N. Y., has been appointed by President McKinley United States Commissioner of Patents, to succeed Mr. Duell, resigned. A dispatch from Indianapolis of March 26 says: "About 20 of the dependent telephone companies of Indiana were represented at a meeting here to-day when a formal protest was adopted against the appointment of Fred. J. Allen, of Auburn, N. Y., as Commissioner of Patents. They claim he is interested in the Bell Company patents and is a director in one of the New York Bell companies. S. P. Sherin, of the Indianapolis company, presided over to-day's meeting. He stated that $75,000,000 is invested in independent plants, which must not be jeopardized in numerous patent cases arising before an interested Commissioner."

EDUCATIONAL.

PURDUE UNIVERSITY.—The annual inspection trip of the electrical engineering department of Purdue University, Lafayette, Ind., is scheduled to take place during the present week. The class will inspect the principal electrical plants in Chicago, the work covering four days from March 25 to March 28. The trip is being conducted by Prof. W. E. Goldsborough.

Trade Notes.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, has installed at different time nine Cross oil filters for the Republic Iron & Steel Company, Chicago.

THE ELECTRIC APPLIANCE COMPANY is selling agent for Richmondt electro-galvanized wire conduit tubing, and is now sending out advertising matter giving full information regarding it.

MR. A. R. SCHMIDT has opened a business of electrical contracting and repairing at 461 Broadway, Milwaukee, Wis. He was formerly superintendent of the Milwaukee Electric Railway & Light Company.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Milwaukee, Wis., reported the re-election of its officers, as follows: F. R. Bacon, president; F. L. Pierce, vice-president; H. H. Cutler, general manager; J. G. Hickcox, secretary and treasurer.

REMOVAL.—Messrs. Garrett, Miller & Company, electrical supply dealers and engineers and contractors, Wilmington, Del., announce the removal of their office, shops and warehouse to larger quarters at the corner of Fourth and Orange Streets, Wilmington.

THE FALK COMPANY, Milwaukee, Wis., reports a heavy increase of business. The company is planning to erect a large addition to its plant at once. The company's business abroad is showing a gratifying increase, the orders from England, France and Germany being large.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., is sending out a circular showing various cuts of its apparatus which it is prepared to furnish to its customers who may desire to advertise these goods. The cuts are of desk, bracket and ceiling fans of all styles.

THE MECHANICAL APPLIANCE COMPANY, of Milwaukee, Wis., has been incorporated with a capital of $20,000. The company will engage in the manufacture of small power motors, heat regulating devices and special tools. It is probable that the motor business will receive the greatest attention.

"HIGH VOLT" LAMPS.—The Columbia Incandescent Lamp Company, St. Louis, Mo., is making lamps of 200 to 250 volts, for which some specially interesting claims are made. These lamps are called "high volt" by the company. The company will be glad to answer any inquiries regarding its product.

THE INSPECTORS IN AN ARC LAMP FACTORY.—With this title the General Electric Company has printed a neat and well-illustrated pamphlet in which the manufacture of an arc lamp is followed from inception to the finished and tested product. Every arc lamp user will find the little brochure both interesting and instructive.

THE ELKHART ELECTRIC COMPANY, Elkhart, Ind., was recently incorporated with a capital stock of $100,000. The incorporators are: Martin V. Beiger, Chas. H. Tenney, J. S. Dodge, Chas. Hewitt and James Dushane. The former announcement of this company's incorporation gave its headquarters as Goshen, Ind., which was an error.

THE AMERICAN BRIDGE COMPANY has secured the contract for the bridge over the South Shrewsbury River at Seabright, N. J. This contract includes furnishing cylinder piers and abutments, four deck plate girder spans, and one draw span 220 feet long. The bridge will have a thirty-foot roadway and two seven-foot sidewalks. The contract is with Monmouth County, N. J.

MACHINERY PAINTS.—Messrs. Chas. H. Besly & Company, Chicago, Ill., are the Western representatives of the Pecora machinery paints, and carry a complete stock of these goods. Attention is called to Pecora blow hole cement, which is stated to be something new. This cement will stand under the planer, lathe, file and other finishing operations. It stands 200 degs. of heat and is gas and air tight. Samples will be sent on application.

BANQUETTING FIREMEN.—In appreciation of their services in saving the plant of the Lea Electric Manufacturing Company, of Elwood, Ind., from destruction by fire on March 15, Jacob Loomis, president of the company, gave the firemen an elaborate banquet on March 18. The affair came in the nature of a surprise, the department being summoned to the café expecting to find a fire. Instead, an elaborate menu was in readiness to occupy their attention.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, Newark, N. J., has just issued three new bulletins descriptive of the different types of lamps made by it. Bulletin 114 C relates to the company's series alternating-current enclosed arc lamp; bulletin 15 A describes its multiple direct-current lamp, and bulletin 13 A the multiple alternating-current enclosed arc lamp. The different styles of these lamps are illustrated, together with views of the constituent parts.

NEW YORK CENTRAL BRIDGES.—According to F. L. Chase, bridge engineer for the New York Central Railroad, that road expended last year nearly $2,000,000 for bridge work, and this year will expend an equal amount. A few days ago the company asked for bids on 28,000 tons of steel work, comprising several hundred spans. This is the largest single contract for bridge material ever let by any railroad company in the United States, and the contract for the whole lot was awarded to the American Bridge Company.

WATER TUBE BOILERS.—The Cincinnati office of the Stirling Company has just closed a contract with the Wellman-Seaver Engineering Company of Cleveland, for 1500-hp. water tube boilers, to be installed in the plant of the Lake Superior Power Company at Sault Ste. Marie. Another contract was for a 600-hp. water tube, to be installed in the plant of the Iroquois Portland Cement Company, at Caledonia, N. Y. The Champion Coated Paper Company of Hamilton has just purchased of the Stirling Company 3200-hp. water tube boilers.

MOTORS FOR AUTOMOBILES.—The De Dion-Bouton Motorette Company, Brooklyn, N. Y., announces that its 1¾-hp. De Dion air-cooled motor is particularly adapted to the requirements of motor bicycle manufacturers. It weighs only 45 lbs., and its average speed is 1,800 to 2,200 r. p. m. The 2½-hp. motor is suitable for tricycles, quadricycles, racing bicycles or motor tandems. When fitted to any one of these types of machines, it does not overheat under full load or speed. The average speed of this motor is from 1500 to 1800 r. p. m.

HYLO BABY FILAMENT LAMPS.—The Central Electric Company, of Chicago, is sales agent for the new incandescent lamp called the "Hylo Baby Filament Lamp." It has two distinct filaments, one giving 1 candle-power and the other 16 candle-power. Changing the light from 1 to 16 candle-power, or vice versa, is done by slightly turning the lamp in the socket. This does not introduce a resistance, but the changing mechanism is a part of the lamp and does not require a special socket. They are made in Edison, T. H. and S. M. base, and for from 50 to 125 volts.

"ABOUT A STREET RAILWAY COMPANY."—The foregoing is the title of a little pamphlet issued by the Garton-Daniels Company, Keokuk, Ia. The story, in brief, gives the experience of a certain street railway company in Chicago with Garton lightning arresters. The Garton Company reports that its February business in arresters was double that of any previous February in the history of the concern, and that the March business gives indications of the same rate of increase. Many of the orders are coming from Central America for large electric railways being built there.

AUTOMATIC LUBRICATION.—Mr. H. H. Humphreys, of St. Louis, consulting engineer for the Anheuser-Busch Brewing Association, has specified the "Siegrist System" of automatic lubrication for its new electric light plant. The Memphis Light and Power Co., of Memphis, Tenn., has also specified the "Siegrist system" for its entire station. On account of its increasing business, the Siegrist Lubricator Company has purchased the property at the northeast corner of Second and Vine Streets. A four-story brick structure to cover the entire lot is to be erected, and will be used as a factory for the manufacture of lubricators.

ELECTRIC LOCOMOTIVES FOR MINE HAULAGE.—A recent publication of the Westinghouse Electric & Manufacturing Company is a handsome pamphlet descriptive of electric locomotives for mine haulage. The illustrations consist of excellent half tones showing many styles of mining locomotives, in every case engraved from photographs of equipments supplied to mining companies. The type of motor used with the locomotives is illustrated in complete detail. An instructive feature of the catalogue consists of some pages of engravings showing every part of a locomotive, both mechanical and electrical, and including the slightest details.

PIERSON GAS PRODUCER.—We have received from J. & O. G. Pierson, 54 Faubourg Montmartre, Paris, several pamphlets relating to the Pierson method of gas production for power purposes. One of the pamphlets consists of a report of the well-known authority, Prof. Aime Witz, on a gas engine plant installed to operate a street railway line at Cassell, near Dunkerque, France. A test showed that the consumption of coal per kilowatt-hour was but a little over a kilogramme, or about two and one quarter pounds. The Pierson "Gazogene" system is for the production of poor gas, or what is known here as "water gas." A motto carried on the pamphlets is, "Poor gas enriches those who use it."

Record of Electrical Patents

UNITED STATES PATENTS ISSUED MARCH 19, 1901.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

669,999. ELECTRIC SIGNALING APPARATUS; A. Mensing, Berlin, Germany. App. filed May 25, 1900. A circuit closer comprising an air and water-tight casing and a movable circuit terminal adapted to be moved to close the circuit by a jar or blow on the outside of the casing.

670,006. ELECTRIC EXERCISING MACHINE; N. H. Raymond, Buffalo, N. Y. App. filed Aug. 14, 1900. An elastic cord fitted with handles passes over the pulley on the armature shaft of a magnetic machine; the current generated in the exercising movement passes through the body.

670,022. INTERCOMMUNICATING TELEPHONE SYSTEM; N. H. Holland, Brookline, Mass. App. filed Nov. 12, 1900. In an intercommunicating telephone system, a signal sending circuit at each instrument provided with a selective controlling device; a signal receiving circuit at each instrument independent of said signal sending circuit; and means independent of said selective controlling device for closing either of said circuits.

670,024. PROCESS OF MAKING ACTIVE MATERIAL FOR ACCUMULATOR-PLATES; E. W. Junger, Stockholm, Sweden. App. filed May 12, 1900. (See current News and Notes.)

670,026. ELECTRIC CIGAR LIGHTER; A. B. Kittson, Boston, Mass. App. filed Oct. 24, 1900. A flattened coil of fine platinum wire is protected by a sheet of mica, through which the heat is transmitted to the cigar.

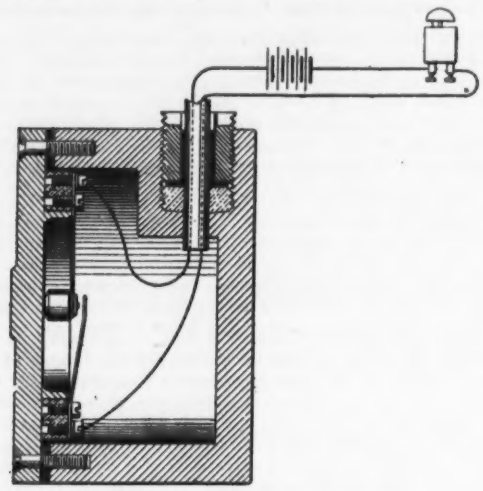
670,059. COMMUTATOR BRUSH HOLDER; W. D. Pomeroy, Akron, Ohio. App. filed Sept. 22, 1900. Details.

670,119. BRUSH HOLDER FOR ELECTRIC MACHINES; J. Trier, Chicago, Ill. App. filed April 26, 1900. A construction whereby the inspection of the brushes is rendered easy.

670,142. ELECTROLYTIC CURRENT INTERRUPTER; Arthur Wehnelt, of Charlottenburg, Germany. App. filed May 16, 1899 . (See page 515 of this issue.)

670,145. ELECTRIC SWITCH; W. F. Bossert, Utica, N. Y. App. filed June 7, 1900. The switch blade consists of two plates spaced apart which are adapted to pass over the outside of a spring clip.

670,149. TIME SWITCH FOR ELECTRIC CIRCUITS; E. I. Dodds, Avalon, Pa. App. filed Sept. 9, 1899. This switch is made on the principle of the hour glass; the moving material being mercury instead of sand, and the circuits being complete as long as the mercury is flowing.



669,999.—Electric Signaling Apparatus.

670,172. ELECTRIC WATER HEATER; W. F. Follett, New Haven, Conn. App. filed Dec. 10, 1900. An arrangement of pipes for circulation of the water, the heating resistance being disposed around the pipes in a manner to protect them.

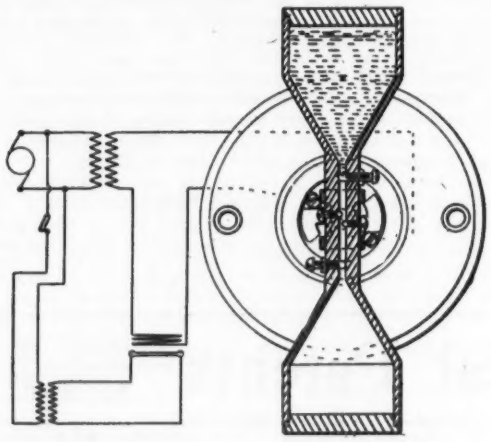
670,174. AMMETER; G. Grabosch, Berlin, Germany. App. filed Oct. 12, 1900. (See Current News and Notes.)

670,201. PROCESS OF PRODUCING ZINC OXID AND NITRITES; Edwin D. Kendall, Brooklyn, N. Y. App. filed Oct. 11, 1900. An electrolyte consisting of an aqueous solution of a nitrite or nitrites is subjected to the action of an electrolytic current passing between an anode formed of zinc and a cathode of carbon, or a suitable metal which sufficiently resists the destructive action of the electrolyte.

670,202. APPARATUS FOR CONTROLLING THE MOTION OF ELECTRIC SWITCHES; W. Kingsland, London, Eng. App. filed Aug. 9, 1900. A brake device to prevent the over movement of a switch element whose stroke is produced by a tappet.

670,203. APPARATUS FOR CONTROLLING THE MOTION OF ELECTRICAL SWITCHES; W. Kingsland, London, Eng. App. filed Aug. 9, 1900. A modification of the preceding.

670,204. APPARATUS FOR CONTROLLING THE MOTION OF ELECTRICAL SWITCHES; W. Kingsland, London, Eng. App. filed Aug. 9, 1900. A still further modification.



670,149.—Time Switch for Electric Circuits.

670,252. IGNITING DEVICE; E. Schmidt, Wilmersdorf, Germany. App. filed Jan. 19, 1900. A form of gas lighter in which a weight is employed to assist in turning on the gas.

670,274. SWITCH FOR SUSPENDED ELECTRIC CONDUCTORS; J. Floyd, Washington, D. C. App. filed Feb. 2, 1900. The switch is for an over running trolley, and is formed by branching and looping the wires themselves in a peculiar way.

670,278. REVERSING APPARATUS FOR ELECTRICAL DEVICES; R. J. Hughes & A. B. Shaw, Duquesne, Pa. App. filed Oct. 13, 1900. An electromagnetic device for automatically reversing a dynamo by changing the direction of current in the leads to its field magnet or armature.

670,316. INCANDESCENT LAMP; R. A. Fessenden, Allegheny, Pa. App. filed Nov. 27, 1900. (See Current News and Notes.)

670,319. UNDERGROUND CURRENT SUPPLY FOR ELECTRIC RAILWAYS; H. T. Hillischer, Vienna, Austria-Hungary. App. filed Oct. 26, 1900. Details for the ready removal of the cover of the contact box.

670,350. ELECTRO-ENDOSMOTICALLY FREEING MATERIALS FROM FLUIDS; Botho Schwerin, Munich, Germany. App. filed July 26, 1900. The process is based upon the fact that when an electric current passes through a liquid the molecules of the latter are caused to travel from the positive electrode to the negative one, where the liquid accumulates. The material to be treated is brought into contact with the positive and negative electrodes by placing it between the same; electric current is passed through the mass by means of the electrodes and the fluid is allowed to discharge at the negative electrode. The material is preferably operated upon in the state of a pulp, sludge, mud or slime.

670,351. APPARATUS FOR ELECTRO-ENDOSMOTICALLY FREEING MATERIALS FROM FLUIDS; Botho Schwerin, Munich, Germany. App. filed July 26, 1900. There are two cylinders one within the other, the inner one constituting the positive and the outer the negative electrode. The outer cylinder is constructed of wire and gauze with an external covering of canvas. Materials such as peat pulp to be freed of moisture, are fed between the two cylindrical electrodes by means of a rotating spiral working in the annular space, which causes the material during its passage through the apparatus to pass repeatedly from the outer to the inner electrode, thus preventing too dry a layer of material from forming in front of the positive electrode.

670,363. ELECTRICAL COUPLING OR TERMINAL; W. Walker, Jr., Birmingham, Eng. App. filed Sept. 15, 1900. The end of the conductor goes into the split end of a plug, the plug being conical and screw threaded externally, and adapted to receive a cup which screws over to bind the end of the wire.

670,375. CONTACT SHOE LIFTING APPARATUS FOR ELECTRIC CARS; J. S. Morrison, Richmond Hill, N. Y. App. filed April 20, 1900. Mechanical devices whereby the shoe can be lifted from the car platform by means of a lever.

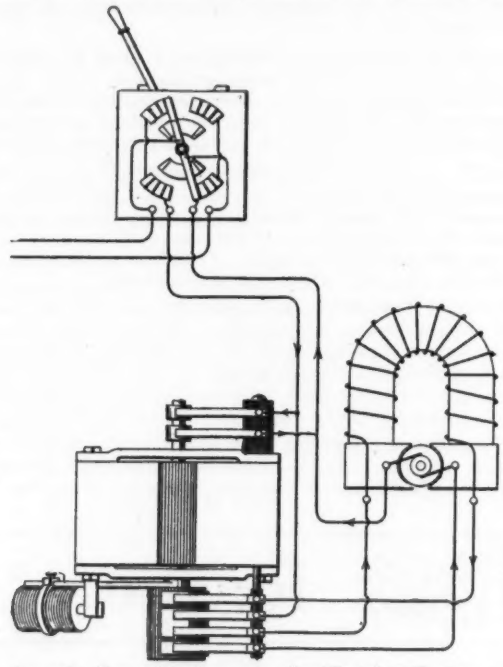
670,376. EXTENSION PLUG; P. H. Quinn, Pasadena, Cal. App. filed June 11, 1900. The plug is arranged so that when it is screwed into the socket the wire is not twisted.

670,380. CURRENT INTERRUPTER IN CONDUCTING RAIL CONTACT SYSTEMS; J. F. Bjurlund, Richmond Hill, N. Y. App. filed Sept. 26, 1900. Mechanical apparatus for lifting the shoe out of contact with the third rail.

670,382. TROLLEY WHEEL; J. Caldwell, Providence, R. I. App. filed June 9, 1899. Inside of the hub and around the axle are placed two reversely wound coil springs, which feed the lubricant along the axle.

670,384. TROLLEY ROPE HOLDER; J. W. Clayton, Denver Colo. App. filed Nov. 1, 1900. A spring catch placed upon the hood of the car for holding the rope.

670,408. SIGNALING APPARATUS FOR TELEPHONE STATIONS; T. W. Loaring, Cleveland, Ohio. App. filed Oct. 27, 1900. Details.



670,278.—Reversing Apparatus for Electrical Devices.

The following patents, issued March 5, were delayed in being forwarded by the Patent Office:

669,233. ELECTRIC IGNITER FOR EXPLOSIVE ENGINES; Wm. F. Davis, Milwaukee, Wis. App. filed Jan. 2, 1900. Relates to mechanism for suddenly separating sparking electrodes within the gas chamber.

669,429. COIN-CONTROLLED ELECTRIC CIRCUIT CLOSER; Wm. Howard Paine, Providence, R. I. App. filed March 14, 1900. A normally open circuit including a motor, means for closing the circuit governed by a mechanism in connection with the motor, and a coin-controlled mechanism for primarily releasing a member of the circuit closer. The circuit may be closed for a period of time and automatically opened when the work of the automatically operated mechanism is completed.

No Central Office Expense

For Towns Factories Warehouses Hotels and Offices

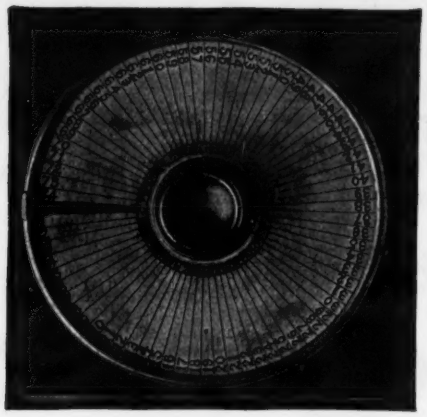
Not an Experiment: Demonstrated Thoroughly Practical

By Actual Use Thoroughly Tested

THE CLARK AUTOMATIC TELEPHONE SYSTEM

—The Acme of Simplicity Economy Effectiveness

"You turn the dial



—we do the rest!"

Glad to answer all your questions

THE CLARK AUTOMATIC TELEPHONE SWITCHBOARD CO.

Banigan Building

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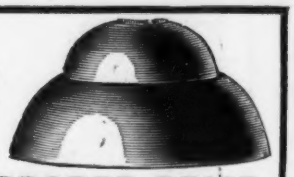

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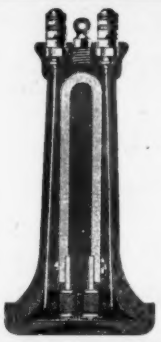

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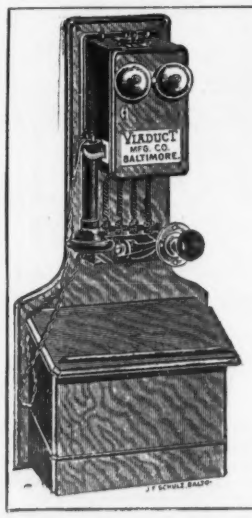

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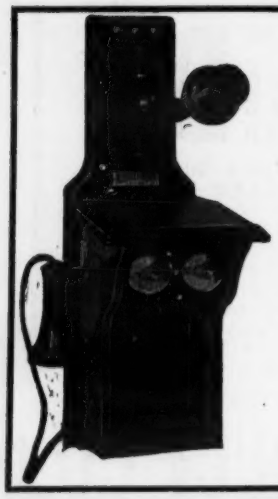

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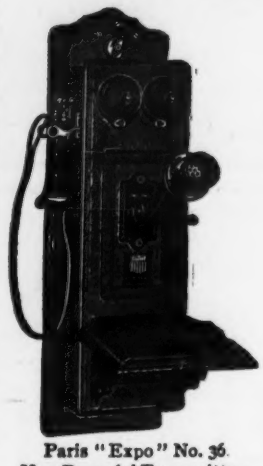

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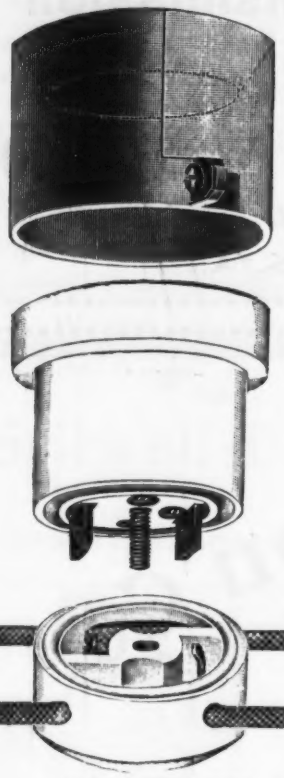

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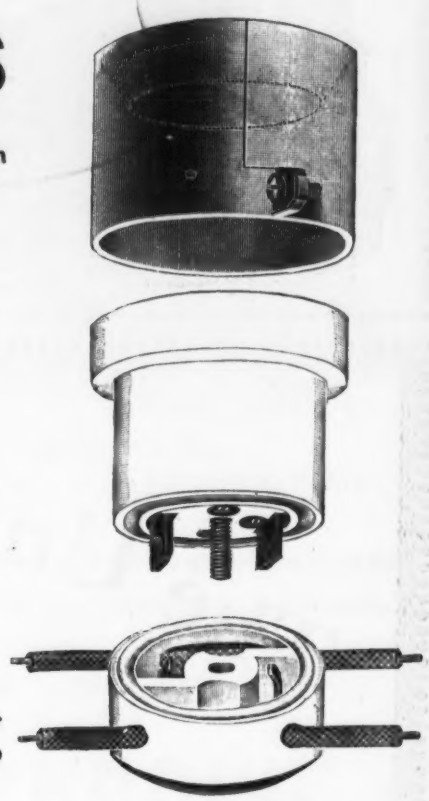

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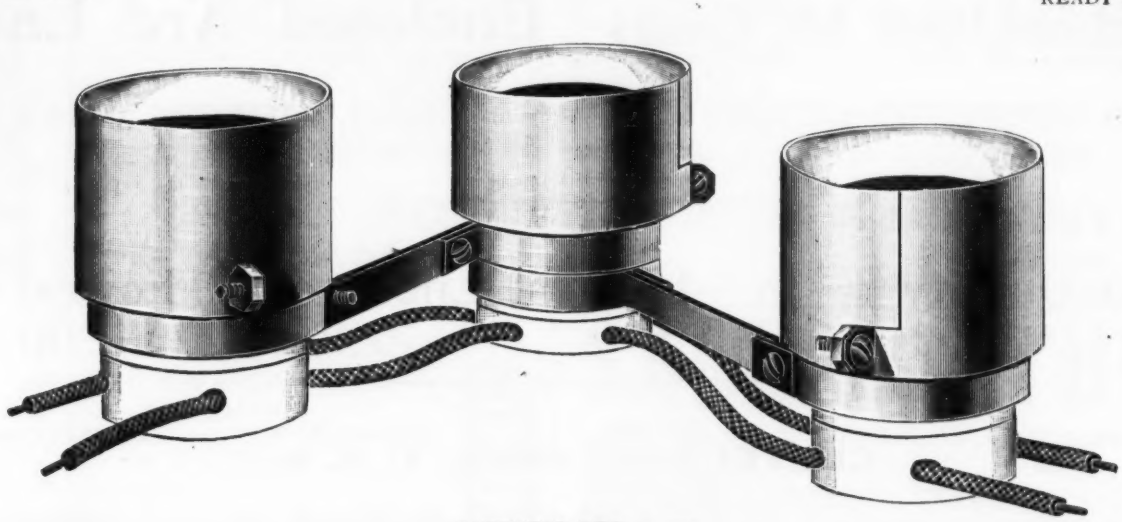

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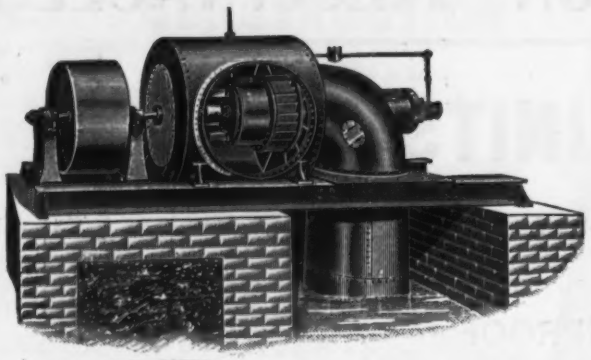

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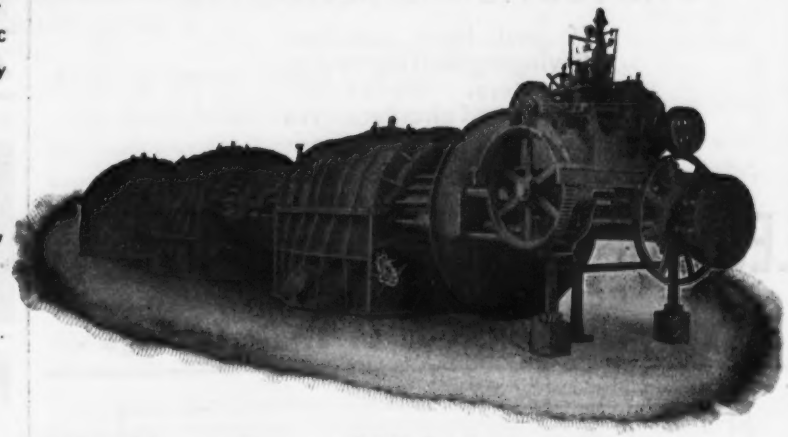

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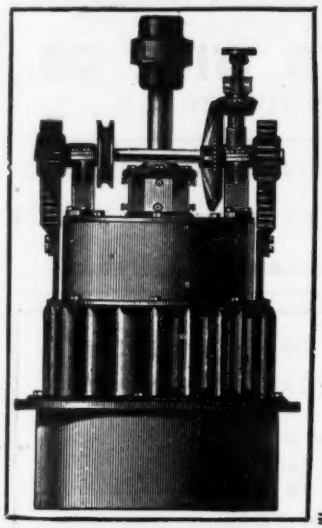

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